X-RAY Astronomy 2009

Present Status, Multiwavelength Approach and Future Perspectives

Book of Abstracts

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X-rays, Stars and Planetary Systems

J.Drake

CfA - MS 03

The scope of stellar X-ray astronomy going into the new decade is quite different to that at the dawn of the Chandra and XMM-Newton era.

X-ray observations of stellar systems over the last ten years have provided detailed information on the characteristics of hot, magnetized astrophysical plasmas and their stellar environments. Iwill discuss this progress and how high energy stellar physics is now central to problems as diverse as the evolution of supernova Type 1a progenitor candidates, planet formation, and the survival of life on young planetary systems. X-rays will play a special role in the multi-wavelength panoply of instruments that will be brought to bear on some of these difficult problems in the next decade.

X-ray emission from star forming regions

E. Flaccomio

INAF Osservatorio Astronomico di Palermo

The first X-ray telescopes unexpectedly revealed that young pre-main sequence stars of almost all masses are intense sources of X-rays, with luminosities well above those of main sequence stars. Most of the X-ray emission from the low mass stars soon appeared to be of `coronal' origin, qualitatively similar that of the Sun and of other main sequence stars, even though with several important quantitative differences. Later missions, such as Chandra and XMM-Newton, allowed a better characterization of the coronal emission and uncovered additional X-ray emission mechanisms, related to the peculiarities of young stellar systems, such as shocks at the base of mass accretion funnels, and within protostellar jets.

X-ray observations of star forming regions have proved of fundamental importance for star formation studies at large: detection of the X-ray bright young stars is one of the most efficient techniques to select members of star forming regions that are affected by significant field stars contamination. Moreover, there is growing evidence that the X-ray emission from the central objects can have a profound impact on the circumstellar environment, and in particular on the structure and temporal evolution of circumstellar disks.

I will review the main observational results, as well as the open questions, regarding the physical origin of the X-ray emission from young stars, and their effects on the circumstellar environment.

Suzaku monitoring of the Wolf-Rayet binary WR140

Y. Sugawara[(1)], *Y. Tsuboi*[(1)], *Y. Maeda*[(2)], *Suzaku WR140 Team*

[(1)]Chuo University, 1-13-27 Kasuga, Bunkyo, Tokyo, JAPAN
[(2)]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency 3-1-1 Yoshinodai, Sagamihara, Kanagawa, JAPAN

We present Suzaku observations of the W-R binary WR 140 (WC7+O5I), with the aim of understanding the W-R stellar wind as well as the wind-wind collision shocks. We detected hard X-ray excess in the HXD band. This is the first time that the hard X-ray excess above 10 keV was detected from a W-R binary. WR 140 is a long-period (P=7.94 yrs), and extremely eccentric (e=0.88) binary. Our observations were made at four different epochs around periastron passage in Jan. 2009. The total exposure was 210 ksec. We obtained the high-quality XIS spectra in each epochs. The XIS spectra show emission lines from various kinds of highly ionized ions. It is found that the absorption-corrected line flux of Fe XXV K alpha varies roughly in inverse proportion to the separation of the two stars before the X-ray maximum but later drops toward periastron. The XIS spectra can be fitted by two different temperature components, with a soft component at kT~ 0.1-1 keV and a harder component at kT~ 3 keV. The column density at periastron is a factor of 30 higher than that at pre-periastron, which is probably due to self-absorption of the W-R wind. Moreover, we found a part of the soft component is not absorbed even by the dense wind. Here, we will discuss the interpretations of our results.

STARS

Posters

The Coronal Properties of the High-Metallicity G IV-V Star 11 LMi

S. A. Drake[(1)], *R. A. Osten*[(2)]

[(1)]USRA/CRESST, Code 662, GSFC, Greenbelt, Maryland, USA
[(2)]StScI, 3700 San Martin Dr., Baltimore, Maryland, USA

The coronal abundances of late-type stars have been found to show at least 3 different patterns (the First Ionization Potential (FIP) effect (as seen in much of the solar corona), the Inverse-FIP effect (as seen in very active stars such as RS CVn binary systems), and an intermediate pattern of abundances with a slight U-shaped dependence on FIP), which appear to be mostly controlled by the level of stellar activity (low, high, and intermediate, respectively). The influence of stellar metallicity on stellar coronal properties is still unclear, since most of the stars with well-studied coronal spectra have photospheric abundances similar to (or assumed to be) the solar photospheric values. We have used XMM-Newton to observe 11 LMi (= HD 82885), a known X-ray source, which has supersolar (2.0 -2.5 times solar) photospheric abundances, in order to study the effect of the high intrinsic metallicity on the temperature structure and abundances of its coronal plasma. We present and discuss the EPIC and RGS spectra of 11 LMi that we have obtained, and compare the properties of its coronal emission with those of similar stars of solar or lower metallicity.

**The role of structured OB supergiant winds
in producing the X-ray flaring emission from High Mass X-ray Binaries**

L. Ducci[1,2], *L. Sidoli*[2], *A. Paizis*[2], *R. Romano*[3], *S. Mereghetti*[2]

[1]Dipartimento di Fisica e Matematica, Universita' degli Studi dell'Insubria, Via Valleggio 11, Como, Italy
[2]INAF, Istituto di Astrofisica Spaziale e Fisica Cosmica, Via E. Bassini 15, Milano, Italy
[3]INAF, Istituto di Astrofisica Spaziale e Fisica Cosmica, Via U. La Malfa 153, Palermo, Italy

We have developed a clumpy wind model for OB supergiants with both a spherical and a non spherical symmetry. We have explored the resulting effects of the accretion of a clumpy wind onto a neutron star in High Mass X-ray Binaries (HMXBs), in order to explain the observed X-ray behavior. The class of HMXBs includes both sources with persistent X-ray emission and the new class of the Supergiant Fast X-ray Transients (SFXTs), characterized by transient X-ray activity, with short flares (a few hours long) reaching a peak luminosity of 10^{36} - 10^{37} erg/s, and a fainter flaring activity at a level of 10^{33} - 10^{34} erg/s. The quiescent level (~10^{32} erg/s) is a much rarer state, observed only in a few SFXTs. A few persistent HMXBs also show flares with properties similar to those observed in SFXTs. We have applied our clumpy wind model both to persistent HMXBs and to SFXTs and we discuss the results.

A Smoking Gun in the Carina Nebula

K. Hamaguchi, M.F. Corcoran, Y. Ezoe, L. Townsley, P. Broos, R. Gruendl, K. Vaidya, S. M. White, T. Strohmayer, R. Petre, Y.-H. Chu

CRESST and X-ray Astrophysics Laboratory NASA/GSFC, Greenbelt, MD 20771, USA

Massive stars are born from giant molecular clouds along with many lower mass stars, forming a stellar cluster or association. They dominate the pressure of the interstellar gas through their strong UV radiation, stellar winds and, ultimately, supernova explosions at the end of their life. These processes help the formation of the next generation of stars, but this trigger of star formation is not yet well understood.

The Carina Nebula is one of the youngest, most active sites of massive star formation in our Galaxy. In this nebula, we have discovered a bright X-ray source that has persisted for ~30 years. The soft X-ray spectrum, consistent with a kT ~128 eV blackbody with mild extinction, and no counterpart in the optical and infrared wavelengths indicate that it is a 10^6 year-old neutron star. Current star formation theory does not allow the progenitor of the neutron star and the other massive stars in the Carina Nebula (in particular Eta Carinae) to be coeval. This result suggests that the Carina Nebula experienced at least two episodes of massive star formation. The neutron star may be responsible for part or all of the diffuse X-ray emission which permeates the Nebula.

X-ray coronae and stellar magnetospheres

G.A.J. Hussain [(1)], *N.S. Brickhouse* [(2)], *A.K. Dupree* [(2)], *M. Jardine*[(3)], *F. Favata* [(4)] *& S.H. Saar* [(2)]

[(1)]ESO, Garching, Germany
[(2)]Harvard Smithsonian CfA, Cambridge, USA
[(3)]Univ. of St Andrews, St Andrews, UK
[(4)]ESA, Paris, France

We describe how X-ray spectra can be used to probe coronal structure in magnetically active cool (F-M-type) stars. Multi-wavelength studies involving contemporaneous X-ray and optical observations allow us to trace the structure of stellar magnetospheres, from their surfaces through their chromospheres to their coronae. The structure of stellar magnetospheres affects how the central star interacts with its surrounding environment, this is particularly important in the evolution of young stars with disks.

Through measurements of densities, temperatures and velocities of the X-ray emitting plasma in active stars we can deduce the structure of the "quiet" coronae. With combined surface maps we can build 3-D models of the magnetospheres of these systems.

In this presentation we show how results of previous studies of binary and single stars (including binaries and single stars, e.g., AB Dor) and new results (including the active eclipsing binary system, YY Gem, the young ultra-fast rotating star, AP 139, and several T Tauri star systems) are showing interesting trends. In conclusion we discuss what the basic requirements are necessary to make progress in the future.

XMM RGS absorption line spectra of the expanding ejecta in the nova V2491 Cyg

J.W. Ness

ESAC/ESA, Apartado 78, 28691Villanueva de la Canada, Madrid, Spain

The outburst of the fast nova V2491 Cyg (2008) was monitored in X-rays and UV by Swift. On day 39.9 after outburst, shortly after the X-ray brightest evolutionary phase, the supersoft source (SSS) phase, started, an XMM-Newton Target of Opportunity observation was taken, and a bright continuum spectrum with absorption lines was observed. 10 days later (day 49.7), a second XMM-Newton observation was carried out. The absorption lines are broadened and blue-shifted, consistent with -3000 km/s. The lines originate from H-like and He-like ions of O, N, and C. In addition, the interstellar lines of OI and NI are observed at their rest wavelengths. A number of unidentified lines are seen. None of the lines are saturated, although the OVIII line profile has a flat bottom. This indicates that this absorption line originates from deep within the outflow. The observation on day 49.7 is a factor five fainter in brightness, but the absorption lines have a similar profile and are shifted by the same amount. At short wavelengths, below 17A, the continuum emission is brighter than on day 39.9. At short wavelengths, weak emission lines of NeX and NeIX can be identified that do not change in strength. I will show simultaneous X-ray and UV light curves and the RGS spectra, extracted from different time intervals. I will discuss possible interpretations and the requirements for models.

Panchromatic imaging of 30 Doradus from the x-rays to the IR with Chandra and HST/WFC3

F. Paresce

IASF Bologna, Via Piero Gobetti 101, Bologna, Italy

We will carry out with guaranteed time of the HST/WFC3 broad-band multi-wavelength imaging over the entire range from the UV to the near-IR, aimed at studying the ages and metallicities of stellar populations, revealing young stars that are still hidden by dust at optical wavelengths, and showing the integrated properties of star clusters. Narrow-band imaging of the same environments will allow us to measure star-formation rates, gas pressure, chemical abundances, extinction, and shock morphologies. For this last objective, we will compare the WFC3 observations with Chandra images of the same region in order to clearly delineate the proceses that regulate the energy feedback from the ISM. These processes are highly efficient in depositing energy in the ISM “outside” the starburst in this SFR. If this is a general property, this would imply a high feedback efficiency in starbursts (ε~1), of the level needed by models of galaxy evolution.

The population of young stars in Orion A: X-rays and IR properties

I. Pillitteri[(1)], *S. Wolk*[(1)] , *L. Allen*[(2)], *T. Megeath*[(2)] *and SOXS collaboration*

[(1)]High Energy Astrophysics Div. of SAO-Harvard Center for Astrophysics, 60 Garden St, Cambridge, 02138 MA USA
[(2)]National Optical Astronomy Observatory, USA
[(3)]Department of Physics & Astronomy, University of Toledo, OH, USA

Stars in the very early stages of their formation are characterized by strong IR excess and X-rays emission. We present the results of the survey of Orion A/ L1641 region in both IR and X-rays obtained with Spitzer and XMM-Newton observatories. We study the IR classification of the Young Stellar Objects (YSOs) population using IR colors from 2MASS + Spitzer (IRAC & MIPS) and by means of X-rays fluxes, luminosities and plasma temperatures. We discuss clustering properties and spatial segregation among different IR class YSOs in order to track the formation history.

The LETGS spectrum of delta Ori

A.J.J. Raassen[1] , *A. Pollock*[2]

[1]SRON, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands
[2]ESAC, Apartado 50727, Villafranca del Castillo, 28080 Madrid, Spain

The O-giant delta Ori was observed in the wavelength range 5-175 Å by the X-ray detector HRC-S in combination with the grating LETG on-board CHANDRA. Lines above 40 Å are suppressed.

We perform a multi-temperature fit and we model the differential emission measure (DEM) of the spectrum, resulting in a temperature distribution, emission measures, and elemental abundances.

Individual line fluxes and width have been measured.

Based on the intercombination and forbidden lines in He-like ions the formation of these ions relative to the stellar surface can be established.

Eclipsing by the nearby companion results in an additional confirmation of these results.

SUPERNOVAE REMNANTS AND PULSAR WIND NEBULAE

Orals

Pulsar wind nebulae: X-ray and multiwavelength observations

O. Kargaltsev, *G. Pavlov*

University of Florida, USA

Most of the pulsar rotational energy is lost via the wind comprised of relativistic particles and magnetic fields. The wind shocked in the ambient medium produces synchrotron nebulae observable from the radio through gamma-rays. X-ray observations proved to be particularly efficient in studying pulsar winds.

Chandra and XMM-Newton have discovered more than 70 pulsar-wind nebulae (PWNe) with very different appearances, spectra and luminosities. Some of these PWNe have been also detected in the radio and high-energy gamma-rays. The shape, spectrum, and radiative efficiency of a PWN depend on the angular distribution, magnetization and energy spectrum of the unshocked wind, particle acceleration mechanism, pulsar velocity and properties of the ambient medium.

I will overview and summarize recent observational results on PWNe and pulsars, paying special attention to the cases where the observational results challenge our current understanding of pulsar winds.

High energy aspects of SNRs

A. Bamba

ISAS/JAXA

Supernova remnants (SNRs) are main suppliers of thermal energy, heavy elements, cosmic rays, and so on. In other words, SNRs make diversity in the universe.

These 15 years X-ray observations revealed us directly for the first time that shocks of SNRs accelerate high energy electrons and possibly protons. The quantitative study of cosmic-ray acceleration efficiency and the maximum energy of accelerated particles are also available with the new generation X-ray satellites. However, it is still an unsolved problem how much cosmic rays are really accelerated on the SNR shocks.

We will summarize the recent achievements on cosmic-ray acceleration in SNR shocks with X-ray and gamma-rays, including not only Chandra, XMM, Suzaku results, but also H.E.S.S. and Fermi observations.

Discovery of a hard X-ray spectrum from the mixed morphology SNR W28 with XMM-Newton

R. Nakamura[1], *A. Bamba*[1], *M. Ishida*[1], *R. Yamazaki*[2], *K. Tatematsu*[3]

[1]Institute of Space and Astronautical Science (ISAS)/ Japan Aerospace eXploration Agency (JAXA), 3-1-1 Yoshinodai, Sagamihara, Kanagawa, Japan
[2]Hiroshima University, 3-2, Kagamiyama, Higashihiroshima, Hiroshima, Japan
[3]National Astronomical Observatory of Japan, 2-21-1, Osawa, Mitaka, Tokyo, Japan

We report on the discovery of very hard emission from the inner region of the mixed morphology supernova remnant (SNR) W28 with XMM-Newton. We analyzed the XMM-Newton data of the north-eastern part of W28, and discovered a power-law component with a photon index of 1.1 (0.41-1.7) from the inner region. This indicates the possibility of a particle acceleration. The spectrum is as hard as that found from the SNR γ Cygni of 0.8-1.5 (Uchiyama et al. 2002), and G156.2+5.7 of ~1.5 (Katsuda et al. 2009). The shell region spectra, on the other hand, are in general found very close to those of plasma in ionization equilibrium with a temperature of ~0.3 keV, and with a very high density of ~9 cm^{-3}. This high compression may result from collision of the plasma with molecular clouds. We only have upper limit on the X-ray flux from the TeV γ -ray emission region. Assuming a power-law spectrum with a photon index of 2.7, we obtained an upper limit on the surface brightness to be 4.1×10^{-8} ergs/s cm^2 sr.

SUPERNOVAE REMNANTS AND PULSAR WIND NEBULAE

Posters

Suzaku Observation of the Diffuse X-Ray Emission from the OpenCluster Westerlund 2: a Hypernova Remnant?

Y. Fujita, K. Hayashida, H. Takahashi , F. Takahara

Department of Earth and Space Science, Graduate School of Science, Osaka University, Toyonaka, Osaka 560-0043, Japan

We present the analysis of a Suzaku Observation of the open cluster Westerlund 2, which is filled with diffuse X-ray emission. We found that the emission consists of three thermal components or two thermal and one non-thermal components. The upper-limit of the flux of the non-thermal component is small compared with the TeV gamma-ray flux observed with H.E.S.S. This may indicate that active particle acceleration has stopped in this cluster, and that the accelerated electrons have already cooled. We suspect that the gamma-ray emission observed with H.E.S.S. comes from high-energy protons, which hardly cool in contrast with electrons. The protons would have been accelerated at a supernova remnant ~10^5-10^6 yrs ago. Considering the fact that stars with masses of ~80 M_sun still survive in Westerlund 2 and more massive stars die earlier in an open cluster, the progenitor star would have exploded as a hypernova with a mass of ~80 M_sun rather than as a normal supernova. Metal abundances of the diffuse X-ray gas would indicate the explosion of such a massive star.

Radio and X-ray Properties of Galactic Supernova Remnants G7.7-3.7 and G344.7-0.1

E. Giacani[1], *N. Loiseau* [2], *M. J. S. Smith* [2] , *G. Dubner* [1], *M. Iacobelli*[2]

[1]Instituto de Astronomía y Física del Espacio, (IAFE), CC 67, Suc. 28, 1428, Buenos Aires, Argentina.Affiliation, Address, City, Country
[2]XMM-Newton Science Operation Center, ESAC, Villafranca del Castillo , Spain.

Galactic supernova remnants (SNRs) exhibit a wide variety of morphologies which may be the product of properties of the progenitor star, the explosion mechanism, the presence of a central compact object and the physical conditions of the surrounding interstellar medium (ISM). Multi-wavelength observations are useful tools to understand the role of those factors and the relevance of each of them in the present X-rays/radio emission distribution and spectra of the remnants. In this work we jointly analyze radio and X-ray observations of the galactic SNRs G7.7-3.7 and G344.7-0.1, looking for phenomenological explanations for the observed double-shell morphology seen in these SNRs in the radio band.

Suzaku observation of TeV J2032+4130

H. Murakami, *S. Kitamoto*

Rikkyo University, 3-34-1 Nishi-Ikebukuro, Toshima-ku, Tokyo, Japan

TeV J2032+4130 is the first unidentified TeV source discovered by HEGRA. The position is coincident with OB association Cyg OB2, and north of microquasar Cyg X-3. These two sources are suggested to be a possible origin of TeV gamma-rays, but no clear relation has been found. Unidentified TeV objects have key information to reveal the acceleration mechanism of cosmic rays, and multi-wavelength observations are vitally important to reveal the emission mechanism.

We observed TeV J2032+4130 with Suzaku for about 40 ksec. With the high sensitivity for detection of diffuse X-ray emission, we found two small structures in the TeV emitting region. By subtracting the contribution of point sources estimated by Chandra observation, we obtained diffuse X-ray spectra. Both spectra can be reproduced by a power-law model with a photon index of about 2, and an X-ray flux of 2 times 10^{-13} erg s^{-1} cm^{-2}. The ratio of the gamma-ray flux to the X-ray flux is about 10. If the origin of TeV gamma-ray is inverse Compton of microwave background, this ratio corresponds to the magnetic field of about 1 μG.

Combining with other observations, such as VLA or molecular clouds, the emission mechanism of TeV gamma-ray will be discussed.

GAMMA-RAY BURSTS

Orals

X-ray and multi-wavelength observations of Gamma Ray Bursts

C. Kouveliotou

NASA, MSFC

The launch of the Italian (with Dutch participation) satellite BeppoSAX in 1996 enabled the detection of the first X-ray GRB afterglow, which in turn led to GRB counterpart detection in multiple wavelengths. This breakthrough firmly established the cosmological nature of GRBs. However, afterglow observations of GRBs took off in large numbers after the launchm of NASA's Swift satellite in 2004. Swift enabled multiple major discoveries, such as the early lightcurves of X-ray afterglows, the first detection of a short GRB afterglow and opened more questions such as where are the elusive breaks in afterglow light curves. I will describe here these results and will discuss future opportunities and improvements in the field.

GRB emission models and multiwavelength properties

G. Ghisellini

INAF-Osservatorio Astronomico di Brera, Milano (Italy)

One of the major unknowns concerning long Gamma Ray Bursts is the radiation process at the origin of the prompt emission.
I will discuss some severe problems faced by the leading processes already proposed for the origin of this radiation.
Then I will present some recent ideas about the early phases of the afterglow, as observed by Swift, concentrating on the relation between the X-ray and the optical emission. I will suggest that the observed characteristics of the afterglows suggest that the central engine can be active for weeks, and is probably fueled by fallback material.

Hard X-ray properties of Gamma Ray Bursts in the Cosmological context

G. Ghirlanda

INAF – Osservatorio Astronomico di Brera, Via E. Bianchi 46, I-23807 Merate (LC)

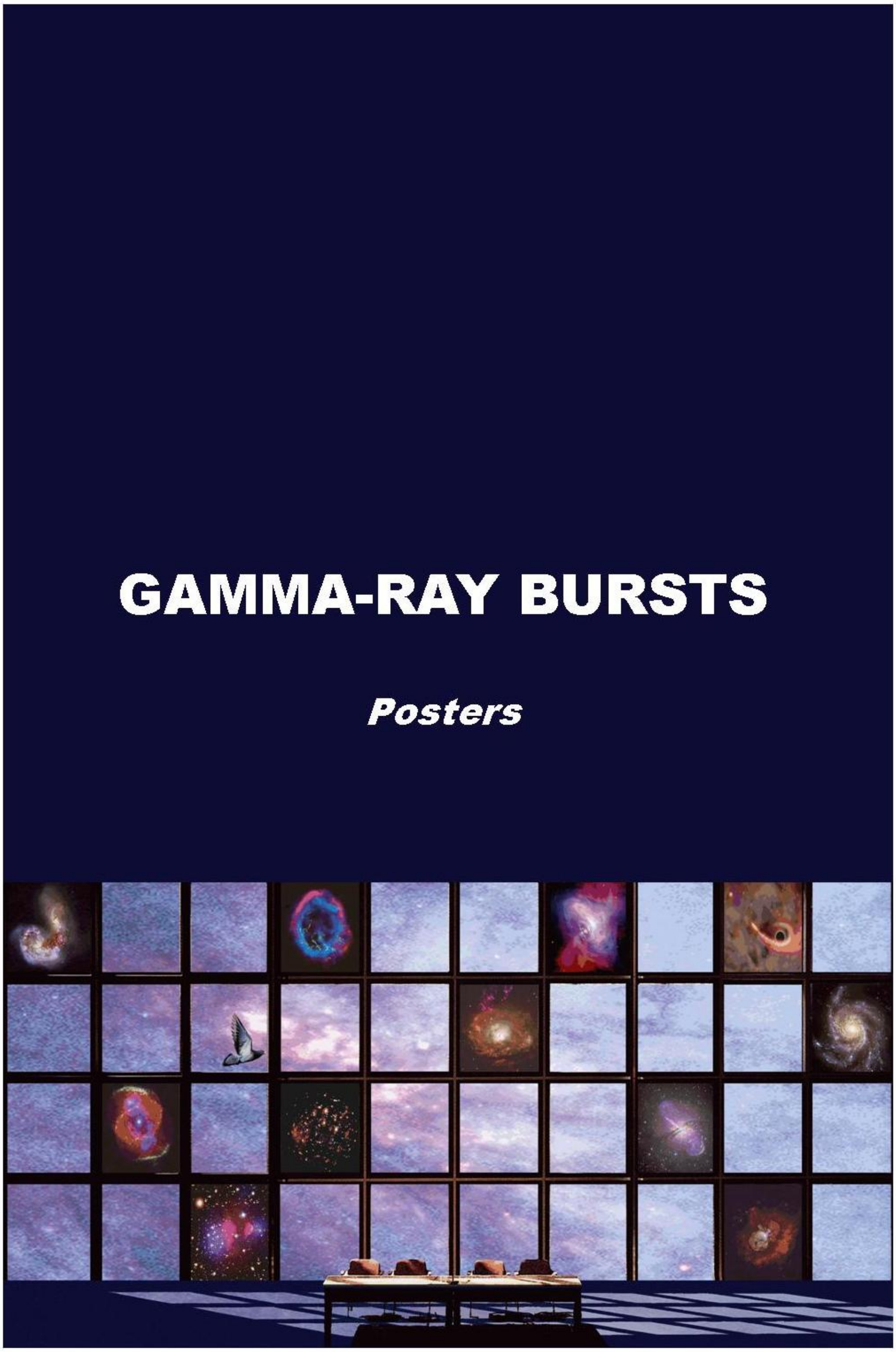
Gamma Ray Bursts (GRBs) are the most powerful sources of the hard X—ray sky and they are observed out to very high redshifts. This makes them appealing tools for cosmology. One possibility is to use GRBs as standard candles. This is possible through some distance indicators, namely strong correlations among their spectral properties, which allow to stardardize GRB total energetics. However, this subject is presently debated. Selection effects and systematic effects (acting on the rest frame spectral-energy correlations) should be considered. The present status of the spectral energy correlations of GRBs and their application for cosmology is presented. New results are shown in support of their physical origin, issues and future possibilities of the use of GRBs as cosmological probes are discussed.

GRB 090423 reveals an exploding star at the epoch of reionization

P. D'Avanzo[1, 2]

[1]Università degli Studi di Milano Bicocca
[2]INAF – Osservatorio Astronomico di Brera, Via Bianchi 46, I-23807 Merate (Lc), Italy

Gamma-ray bursts (GRBs) are extremely luminous gamma-ray flashes produced in Supernova explosions, and detectable up to distances of cosmological interest. Here we report the discovery of GRB 090423, a cosmic explosion occurred when the age of the Universe was only 4% of the current one, corresponding to a redshift z = 8.1. Unexpectedly, this ancient object exhibits properties similar to those of GRBs observed at low/intermediate redshifts, thus suggesting that the mechanisms which produces GRBs in the early and nearby universe are not markedly different. Also it is suggestive of the fact that the massive star which has originated GRB 090423, about 600 milions of years after the Big Bang, shares some of properties which characterize the GRB progenitors exploded bilions of years later. GRB 090423 is the first object discovered into the cosmic transition era, known as dark age, between the time in which the Universe was neutral and opaque, and the time in which it became completely transparent, at the end of the re-ionization era. Its detection provides strong evidence in favor of cosmic GRB evolution in their rate and/or luminosity, suggesting that massive stars form efficiently at those epochs and can play an important role as source responsible for the re-ionization process.


GAMMA-RAY BURSTS
Posters

Indirect detections and analyses of GRBs by ionospheric response

R. Hudec[(1)], *R. Slosiar*[(2)]

[(1)]Astronomical Institute, CZ-251 65 Ondrejov, Czech Republic
[(2)]Partizanske Observatory, Prague, Slovak Republic

We report on the independent and indirect detection of GRBs by their ionospheric response (SID – Sudden Ionospheric Disturbance) observed at VLF (Very Low Frequency), and discus its possible impact on GRB science and investigations in general. Although few such detections have been already reported in the past, the capability of such alternative and indirect investigations of GRBs still remains to be investigated in more details. We present and discuss examples of such VLF/SID detection of GRBs 060124A, GRB080319D a GRB080320A. A network of SID monitors has been created and is operated to detect more GRBs. The importance of these detections for GRB analyses and GRB science in general is still to be further and in full detail exploited. Some possible outcomes in this direction will be outlined and discussed.

Galactic Compact Objects

Orals

Probing ultra-dense matter using the cooling properties of accretion-heated neutron stars in low-mass X-ray binaries

R. Wijnands

University of Amsterdam UVA, Amsterdam (The Netherland)

Neutron-star X-ray transients are a subgroup of low-mass X-ray binaries who occasionally exhibit bright X-ray outbursts fueled by a huge increase of the mass-accretion rate onto the neutron stars. When such systems are in outburst, their neutron stars are heated due to the accretion of matter. The resulting temperature, which can be measured in the quiescent state with sensitive X-ray instruments like those aboard Chandra and XMM-Newton, depend on the properties of the neutron-star matter as well as the long-term averaged accretion rate. In systems which accrete for a prolonged period, the neutron-star crust could be significantly out of thermal equilibrium with the core and when the accretion stops the crust will cool down until it is in equilibrium with the core again. I will present an overview of the most recent results obtained with Chandra and XMM-Newton of several quiescent neutron-star X-ray transients, with the prime focus on those systems which had accreted for many years before returning to quiescence. I will discuss what implications our observations have for the cooling models of accretion-heated neutron stars and thus for the properties of the ultra-dense matter (i.e., in the crust).

A self-consistent approach to the reflection component in NS LMXBs

A. D'Aì[(1)], *R. Iaria*[(1)], *T. Di Salvo*[(1)], *G. Matt*[(2)], *N.R. Robba*[(1)], *D. Ballantyne*[(3)]

[(1)]Dipartimento di Scienze Fisiche ed Astronomiche, Università di Palermo
[(2)]Dipartimento di Fisica, Università degli Studi Roma Tre
[(3)]Center for Relativistic Astrophysics, Georgia Tech, USA

In the last two years, the EPIC/PN of the XMM-Newton satellite has allowed a deep investigation on the nature of the reflection component, present in the spectra of Low-Mass X-Ray Binaries harboring a neutron star (Bhattacharya & Stromayer 2007; Pandel et al. 2008; Papitto et al. 2009; D'Aì et al. 2009). The authors of these works have stressed their attention on the shape of the broad Fe Kalpha line, and they agreed in the interpretation of the line broadness as due to general relativistic effects arising in the disk reflecting matter at few gravitational radii from the compact object. This interpretation is supported by theoretical expectations and by the excellent model to data fitting. However, the reflected spectrum should encompass a variety of other disk reflection features that only a broadband self-consistent model can test. In this presentation I will show the results of this self-consistent approch, using a reflection model adressed for the case of NS LMXBs (Ballantyne 2004) for a set of XMM spectra, where the reflection component is most prominent. This work will show the dependence of the ionization degree of the disk reflecting matter, the iron abundance, the effects of disk geometry on the source state. Moreover, I will show the importance of the contribution of the reflection component also at low energies.

A relativistically smeared spectrum in the neutron star X-ray Binary 4U 1705-44: looking at the inner accretion disc with X-ray spectroscopy

T. Di Salvo[(1)], A. D'Aì[(1)], R. Iaria[(1)], L. Burderi[(2)], M. Dovciak, V. Karas[(3)],G. Matt[(4)], A. Papitto[(2)], S. Piraino[(5,6)], A. Riggio[(2)], N. R. Robba[(1)], A. Santangelo[(6)]

[(1)]Dipartimento di Scienze Fisiche ed Astronomiche, Universita' degli Studi di Palermo, via Archirafi 36 - 90123 Palermo, Italy
[(2)]Dipartimento di Fisica, Universita' degli Studi di Cagliari, SP Monserrato-Sestu, KM 0.7, 09042 Monserrato, Italy
[(3)]Astronomical Institute, Academy of Sciences of the Czech Republic, Bocni II 1401a, CZ-14131 Prague, Czech Republic
[(4)]Dipartimento di Fisica, Universita' degli Studi `Roma Tre', Via della Vasca Navale 84, I-00146 Roma, Italy
[(5)]INAF - IASF di Palermo, via Ugo La Malfa 153, 90146 Palermo, Italy
[(6)]IAAT, University of Tubingen, Sand 1, 72076 Tubingen, Germany

Iron emission lines at 6.4-6.97 keV, identified with fluorescent Ka transitions, are among the strongest discrete features in the X-ray band. These are therefore one of the most powerful probes to infer the properties of the plasma in the innermost part of the accretion disc around a compact object. Here we present a recent XMM observation of the X-ray burster 4U 1705-44, where we clearly detect a relativistically smeared iron line at about 6.7 keV, testifying with high statistical significance that the line profile is distorted by high velocity motion in the accretion disc. As expected from disc reflection models, we also find a significant absorption edge at about 8.3 keV; this feature appears to be smeared, and is compatible with being produced in the same region where the iron line is produced. From the line profile we derive the physical parameters of the inner accretion disc with large precision. The line is identified with the Ka transition of highly ionised iron, Fe XXV, the inner disc radius is Rin = (14 ± 2) Rg (where Rg is the Gravitational radius, GM/c^2), the emissivity dependence from the disc radius is $r^{-2.27 \pm 0.08}$, the inclination angle with respect to the line of sight is i = (39 ± 1) degrees. Finally, the XMM spectrum shows evidences of other low-energy emission lines, which again appear broad and their profiles are compatible with being produced in the same region where the iron line is produced.

The magnetic field of neutron stars: what can Cyclotron Lines tell us?

G. Schönherr[(1)] *on behalf of the MAGNET collaboration: J. Wilms* [(2)]*, P. Kretschmar* [(3)]*,*
I. Kreykenbohm [(2)]*, R.E. Rothschild, S. Suchy* [(4)]*, V. McBride* [(5)]*, C. Ferrigno* [(6)]*, I. Caballero,*
D. Klochkov, A. Santangelo, R. Staubert [(7)]*, et al.*

[(1)]Astrophysikalisches Institut Potsdam (AIP), An der Sternwarte 16, 14482 Potsdam, Germany
[(2)]Dr. Remeis-Sternwarte Bamberg, Universität Erlangen-Nürnberg, Germany
[(3)]European Space Astronomy Centre (ESAC), ESA, Spain
[(4)]University of California San Diego (UCSD), USA
[(5)]University of Southampton, UK
[(6)]IAAT, Germany & ISDC Data Centre for Astrophysics, Switzerland
[(7)]Institut für Astronomie und Astrophysik (IAAT), Eberhard-Karls Universität Tübingen, Germany

"Cyclotron lines" provide the only direct way to measure the magnetic field of neutron stars. Detected as strong absorption features in the X-ray spectra of accreting X-ray pulsars, they provide a powerful tool to screen the line-forming region above the neutron star magnetic poles. The lines result from resonant scattering of the X-ray photons with magnetically quantized electrons in the plasma of accreted material. The scattering events induce energetic transitions of the electrons between their different Landau Levels. The corresponding cross sections have resonances at all quasi-equidistant Landau energies. The scattering therefore produces quasi-harmonic absorption features in the spectrum: Cyclotron Resonance Scattering Features (short: CRSFs or Cyclotron Lines). The analysis of their positions and (observationally clearly resolved!) structure can be used to constrain the physical parameters in the accretion column. It is a difficult task, however, to link the complex theoretical models to observational data. We have undertaken a first approach, constructing the first-ever physical XSPEC model for fitting cyclotron lines. What can we learn from it today - and in the future while observational X-ray astronomy and instrumentation proceeds?

Pulsars and double-pulsars: a multiwavelength approach

M. Burgay

Osservatorio Astronomico Cagliari, Cagliari (Italy)

I will shortly review the multiwavelength characteristics of the rotational powered pulsars focusing on some peculiar object, in particular on the high-energy properties of the first (and unique so-far) double-pulsar system.

A relativistically broadened iron line from an Accreting Millisecond Pulsar

A. Papitto[(1)]*, T. Di Salvo*[(2)]*, A. D'Aì*[(2)]*, R. Iaria*[(2)]*, L. Burderi*[(3)]*, A. Riggio*[(1)]*, M.T. Menna*[(4)]

[(1)]INAF Osservatorio Astronomico di Cagliari, Loc. Poggio dei Pini, Strada 54, 09012 Capoterra (CA), Italy
[(2)]Dipartimento di Scienze Fisiche ed Astronomiche, Università di Palermo, via Archirafi 36, 90123 Palermo, Italy
[(3)]Dipartimento di Fisica, Università degli Studi di Cagliari, SP Monserrato-Sestu, KM 0.7, 09042 Monserrato, Italy
[(4)]INAF Osservatorio Astronomico di Roma, via Frascati 33, 00040 Monteporzio Catone, Italy

For the first time the sensitivity and spectral resolution capabilities of XMM-Newton have been fully exploited to probe the innermost regions of the disc around a fast accreting pulsar. We will present the detection of a broadened iron K line from the 'cornerstone' Accreting Millisecond Pulsar, SAX J1808.4-3658, as well as discussing possible models for its origin. Given the broadband spectral properties of the source, the most probable interpretation for such a broadening is in terms of Doppler and relativistic effects in the inner parts of the accretion disc. This observation therefore allows a direct estimate of the inner disc radius, a key parameter for accretion theories, that indeed turns out to lie exactly where it is expected. As the displacement of a disc around a pulsar is thought to reflect the physics of its interaction with the neutron star magnetosphere, this observation opens the possibility of a measure of the disc evolution under different accretion rates, as well as establishing an invaluable benchmark for the theories describing the formation of quasi-periodic oscillations.

Receding disc causing pulse profile variations and timing noise in accreting millisecond pulsars

Y. Poutanen, A. Ibragimov

Astronomy Division, Department of Physical Sciences, PO Box 3000, 90014 University of Oulu, Finland

A detailed analysis of the RXTE data on the 2002 outburst of accreting X-ray millisecond pulsar SAX J1808.4-3658 is presented. We demonstrate how the area covered by the hotspot at the neutron star surface is decreasing in the course of the outburst together with the reflection amplitude. These trends are in agreement with the natural scenario, where the disc inner edge is receding from the neutron star as the mass accretion rate drops. These findings are further supported by the variations of the pulse profiles, which clearly show the presence of the secondary maximum at the late stages of the outburst after 2002 October 29, when the disc has moved sufficiently far from the neutron star to open the view of the lower magnetic pole. We use this fact to estimate the disc inner radius, the inclination and to constrain stellar magnetic field. We also show that the timing noise and sharp changes in the phase of the fundamental are intimately related to the variations of the pulse profile, which we associate with the varying obscuration of the antipodal spot.

X-ray Observations of New Gamma-ray Pulsars Discovered by Fermi LAT

Y. Kanai for the Fermi LAT Collaboration

Tokyo Institute of Technology, 2-12-1 Ookayama, Meguro, Tokyo, Japan

The Fermi Gamma-ray Space Telescope, launched in June 2008, continues the all-sky survey during its first year with the Large Area Telescope (LAT). Thanks to its large effective area and good angular resolution in the GeV energy band, LAT is resolving increasing numbers of gamma-ray sources, especially those buried in the Galactic diffuse gamma-ray emission. Some bright objects near the Galactic plane, many in former EGRET unidentified sources, have been newly revealed as pulsars by our blind pulsation searches. We have already discovered more than a dozen pulsars starting with the one associated with supernova remnant CTA 1. It is interesting to examine if these pulsars discovered in gamma-rays are intrinsically different from the known radio-loud pulsars with gamma-ray emission, or whether they belong to the same class but are seen with geometries that may miss the narrow radio beams. Obviously, observations in other wave bands are essential. We therefore have started X-ray counterpart searches using Swift and Suzaku. With these observations, we measure their X-ray emission components such as the thermal emission from the neutron star, non-thermal emission from the pulsar magnetosphere, or extended pulsar wind nebular emission. We will compare the gamma-ray and X-ray properties of these new pulsars timed with the LAT with those of radio-loud gamma-ray pulsars, and discuss their differences.

Probing the Physics of Magnetars: our first 30 years

G.L. Israel et al.

INAF – Osservatorio Astronomico di Roma, Via Frascati 33, I-00040, Monte Porzio Catone (RM), Italy

In March 1979 rapid coherent X-ray pulsations were discovered during an intense flare from SGR0506-66, the prototype of the magnetar class. Since then, many advances have been achieved in the study of this class of high energy emitting isolated neutron stars, thought to shine in the X-rays due to the decay of the strongest magnetic fields present in the Uni verse (> 10^{15} Gauss). The results obtained through the study of the transient phenomena displayed by some of them over more than 10 orders of magnitudes of time scale variability (from fraction of milli-seconds up to years) will be shown and discussed, with particular emphasis on the most recent results obtained. Among others are: the discovery of rapid QPOs in the giant flares of SGR1806-20 and SGR1900+14, the study of intermediate flares from SGR1900+14, and the detection of long-duration outbursts from transient Anomalous X-ray Pulsars (XTE J1810−197, CXO J164710.2−455216 and 1E1547.0-5408) monitored through multi-wavelength observations. Information related to the neutron star and magnetosphere structure, the emitting processes, and the confined fireball properties have been inferred and will be discussed on the light of the theoretical model(s).

The spectacular X-ray echo of a magnetar burst

A.Tiengo[(1)], *G. Vianello*[(1)], *P. Esposito*[(1)], *S. Mereghetti*[(1)], *G.L. Israel*[(2)], *L. Stella*[(2)], *F. Bernardini*[(2)], *N. Rea*[(3)], *P. Romano*[(4)], *R. Turolla*[(5)], *S. Zane*[(6)], *D. Gotz*[(7)]

[(1)]INAF, IASF-Milano, via Bassini 15, Milano, Italy;
[(2)]INAF, OA Roma, via Frascati 33, Monte Porzio Catone (RM), Italy;
[(3)]University of Amsterdam, Kruislaan 403, Amsterdam, The Netherlands;
[(4)]INAF, IASF-Palermo, via La Malfa 163, Palermo, Italy;
[(5)]Universita` di Padova, via Marzolo 8, Padova, Italy
[(6)]MSSL, Holmbury St. Mary, Dorking, Surrey, UK
[(7)]CEA Saclay, Orme des Merisiers, Bât. 709, Gif sur Yvette, France

The Anomalous X-ray Pulsar (AXP) 1E 1547.0-5408 reactivated in 2009 January with the emission of dozens of short bursts. Follow-up observations with Swift/XRT showed the presence of multiple expanding rings around the position of the AXP. These rings are due to scattering, by different layers of interstellar dust, of a very high fluence burst emitted by 1E 1547.0-5408 on January 22.
Thanks to the exceptional brightness of the X-ray rings, we could carry out a detailed study of their spatial and spectral time evolution, followed until February 4, when a 50 ks long XMM-Newton observation was performed. This analysis gives the possibility to obtain the first robust measurement of the distance of a Galactic magnetar candidate. We also derived tight constraints on the properties of the dust and of the burst responsible for this rare phenomenon.

XMM-Newton unveils an ultra-massive fast-spinning white dwarf in a peculiar X-ray binary system

S. Mereghetti[(1)], *A. Tiengo*[(1)], *P. Esposito*[(1)], *N. La Palombara*[(1)], *G.L. Israel*[(2)], *L. Stella*[(2)]

[(1)]INAF – IASF Milano, Italy
[(2)]INAF – Osservatorio Astronomico di Roma, Italy

The existence of ultra-massive white dwarfs (M>1.2 Msun) is of particular interest for diverse fields, ranging from the physical properties of matter at high density, to the evolution of single and binary stars. Ultra-massive white dwarfs are also relevant as likely progenitors of Type Ia supernovae.

Here we report new observations, obtained with the XMM-Newton X-ray satellite, that provide compelling evidence, based only on dynamical measurements, for the presence of a white dwarf with mass 1.28+/-0.05 Msun in a peculiar binary system resulting from common envelope evolution.

This ultra-massive white dwarf is rotating only a factor two slower than break-up and it must have a weak magnetic field in order to accrete. Thus this system is a white dwarf analogue of the X-ray binaries in which weakly magnetic neutron stars are spun-up and then recycled as millisecond radio pulsars. The future evolution of this system might lead to a new phase of high mass transfer causing the already massive white dwarf to exceed the Chandrasekhar limit and explode as a Type Ia supernova.

The Swift view of Supergiant Fast X-ray Transients

L. Sidoli [1], P. Romano[2], G. Cusumano[2], L. Ducci[1,3], A. Paizis[1], V. Mangano[2], H.A. Krimm[4,5], S. Vercellone[2], D.N. Burrows[6], J.A. Kennea [6], N. Gehrels[5]

[1]INAF-IASF Milano, Via Bassini 15, 20133 Milano, Italy
[2]INAF-IASF Palermo, Via La Malfa 153, 90146 Palermo, Italy
[3]Dipartimento di Fisica e Matematica, Universita' dell'Insubria, Via Valleggio 11, 22100 Como, Italy
[4]Universities Space Research Association, Columbia, MD, USA
[5]NASA/Goddard Space Flight Center, Greenbelt, MD 20771, USA
[6]Department of Astronomy and Astrophysics, Pennsylvania State University, University Park, PA 16802, USA

Supergiant Fast X-ray Transients (SFXTs) have been recognized as a new class of High Mass X-ray Binaries thanks to the discoveries performed by INTEGRAL. The IBIS/INTEGRAL sensitivity allowed us to catch only the bright flares during the outbursts, peaking at 1E36-1E37 erg/s, and lasting from hundreds of seconds to a few hours, without persistent (or quiescent) emission.
The quiescent level was observed only in a couple of members of the class, with a luminosity of a few 1E32 erg/s and a very soft spectrum, thanks to the more sensitive instruments onboard Chandra and XMM-Newton. We report here on a monitoring campaign with Swift we have been performing since October 2007 of 4 SFXTs. It consists of 2-3 Swift/XRT observations per source per week, allowing us to characterize the long-term properties.
Surprisingly, we found that SFXTs spend most of their lifetime in an intermediate level of X-ray luminosity of 1E33-1E34 erg/s, flaring, and still in accretion. We will discuss all our results about their properties during the different source states (outbursts, intermediate level, quiescence), and we will compare them with the main different debated mechanisms proposed to explain their outbursts.

Discovery of the Most Luminous ULX: Evidence for an Intermediate Mass Black Hole

S. Farrell[(1)], *N. Webb*[(2)], *D. Barret*[(2)], *O. Godet*[(1)], *J. Rodrigues*[(2)]

[(1)]University of Leicester, University Road, Leicester, LE1 7RH, UK
[(2)]CESR, 9 Avenue du Colonel Roche, Toulouse, 31028, France

Ultra-luminous X-ray sources (ULXs) are extragalactic objects located outside the nucleus of the host galaxy with bolometric luminosities >1E39 erg/s. These extreme luminosities – if the emission is isotropic and below the Eddington) limit – imply the presence of an accreting black hole with a mass of ~100–100,000 times that of the Sun. The existence of such intermediate mass black holes is in dispute, and though many candidates have been proposed, none are widely accepted as definitive. Luminosities up to ~1E41 erg/s can be plausibly explained through beaming effects and/or hyper-accretion onto stellar mass black holes. A rare class of ultra-luminous X-ray sources – the hyper-luminous X-ray sources – emit X-rays at luminosities >1E41 erg/s and require increasingly complicated scenarios without invoking the presence of an intermediate mass black hole. We present here the detection in the 2XMM catalogue of a variable X-ray source coincident with a z=0.0224 galaxy with a maximum 0.2–10 keV luminosity of ~1E42 erg/s. The derived luminosity is almost an order of magnitude higher than the previous most-luminous ULX, and is difficult to explain without the presence of an intermediate mass black hole with M > 500 Msun.

Ultraluminous X-ray Sources forming in low metallicity natal environments

L. Zampieri(1), *M. Colpi*(2), *M. Mapelli*(3), *A. Patruno*(3), *T. P. Roberts*(4)

(1)INAF-Astronomical Observatory of Padova, Vicolo dell'Osservatorio 5, I-35122, Padova, Italy
(2)Università Milano Bicocca, Dipartimento di Fisica G.Occhialini, Piazza delle Scienze 3, I-20126, Milano, Italy
(3)Astronomical Institute `A. Pannekoek', Univeristy of Amsterdam, Kruislaan 403, Amsterdam, The Netherlands
(4)Department of Physics, Durham University, South Road, Durham DH1 3LE, UK

Thanks to the unprecedented capabilities offered by some of the major X-ray (XMM, Chandra) and optical (VLT, HST) facilities, in the last few years multiwavelength observations have significantly boosted our understanding of Ultraluminous X-ray Sources (ULXs). Yet, the most fundamental questions on ULXs still remain to be definitively answered: do they contain stellar or intermediate mass black holes (BHs)? How do they form? We investigate in detail the possibility that the BHs hosted in ULXs originate from massive (40-120 solar masses) stars in low metallicity natal environments. Such BHs have a typical mass in the range ~30-90 solar masses and may consistently account for the properties of bright (~1.0e40 erg/s) ULXs. More than ~1.0e5 massive BHs might have been generated in this way in the metal poor Cartwheel galaxy during the last 10 million years and might power most of the ULXs observed in it. Support to our interpretation comes from NGC 1313 X-2, the first ULX with a tentative identification of the orbital period in the optical band, for which binary evolution calculations show that the system is most likely made by a massive donor dumping matter on a ~100 solar masses BH. Measurements of the mass function of ULX binary systems and surveys of ULX locations looking for a statistically meaningful relationship between position, average luminosity and local metallicity will provide a definitive test of our proposal.

Measuring the Spins of Stellar-Mass Black Holes

J. E. McClintock

Harvard-Smithsonian Center for Astrophysics, 60 Garden Street - Cambridge, MA 02138 (USA)

We have determined the spins of five stellar black holes by fitting the thermal component of their spectra to a fully relativistic accretion disk model. We identify the inner edge of the disk with the innermost stable circular orbit (ISCO) predicted by GR, which is solely a function of a black hole's spin and mass. For the continuum-fitting method to succeed, one must have accurate measurements of black hole mass, orbital inclination, and distance, and we are focused on obtaining these data.
Comparably important is our theoretical effort to develop improved GRMHD models of the inner accretion disk. Meanwhile, we are analyzing for selected sources many X-ray spectra obtained by several past and present X-ray missions. We will highlight recently-published work for M33 X-7 and LMC X-1, discuss the observational and theoretical foundations of the continuum-fitting method, and use our results for the much-observed persistent source LMC X-3 to showcase the performance of this method.

X-ray and radio properties of black hole candidates

E. Gallo

MIT Kavli Institute for Astrophysics and Space Research, Cambridge MA, USA

Black holes in Galactic X-ray binaries can be thought of as a form of quasars for the impatiens: what makes them appealing, despite their low number statistics with respect to quasars, are the fast variability time-scales. In the first approximation, the physics of the jet-accretion coupling in the innermost regions should be set by the mass/size of the accretor.

At the same time, allowing for a systematic comparison between different classes of compact objects, X-ray binaries hold the key to identify and characterize properties that may be unique to, e.g., the presence (or lack) of an event horizon. In this talk, I will broadly review the observational properties of black hole X-ray binaries across the entire electromagnetic spectrum, with a special emphasis on modeling broadband spectral energy distributions of black hole vs. neutron star systems, the role of radio outflows, and relativistic iron lines.

Spectral/timing evolution of black-hole binaries

T. Belloni

INAF - Osservatorio Astronomico di Brera, Via E. Bianchi 46, Merate, Italy

Thanks to fourteen years of observations with RossiXTE, we now have a large dataset on black-hole binaries, in particular transient systems. From the time evolution of outbursts, a clear pattern emerges when considering spectral and fast variability information. This pattern is closely related to the properties of relativistic jets observed in the radio band and constitutes the most promising approach to the understanding of the accretion/ejection phenomenon. In particular, fast and major transitions are observed in the timing properties and mark different phases of the outburst, with a complex dependence on mass accretion rate. The spectral evolution through these transitions, in particular at high energies as observed with RXTE/HEXTE and INTEGRAL, is a key path to the understanding of the physical conditions responsible for the emission. I will present the current situation, based on a large number of systems, and discuss the connection with persistent black-hole binaries, peculiar objects and Active Galactic Nuclei.

Jet disc coupling in black hole binaries

J. Malzac [(1)], *R. Belmont*[(1)], *A. Fabian*[(2)]

[(1)]CESR (CNRS - Université de Toulouse), 9 avenue du colonel Roche, 31028 Toulouse, France
[(2)]Institute of Astronomy , Madingley Road, CB30HA, Cambridge, united Kingdom

We discuss the structure of the accretion flow and the intrinsic connection between hot comptonizing corona and compact radio jet in the hard state. we show that the current estimates for the jet power of Cygnus X-1 set a lower limit on the jet velocity. These estimates also imply that the X-ray emission does not arise in the jet as was proposed by several authors. Rather, either a small fraction of the corona is ejected to infinity, or the ejection velocity of the corona is vanishingly low. We also show that in this prototypical X-ray source the coronal magnetic field is below equipartition with radiation (suggesting that the corona is not powered by magnetic field dissipation). Moreover, the ion temperature in the corona is significantly lower than what predicted by ADAF like models. we also present a coupled X-ray corona jet model taking into account acceleration and cooling in both the jet and corona. This model allows us to put additional constraints on the parameters of the system. Finally I discuss the complex short time scale (1s) optical X-ray correlation discovered in several sources that are best interpreted as a signature of jet/corona coupling and suggest the presence of a common energy reservoir powering both the jet and the corona.

Accretion disk in the low-hard state

R. C. Reis[1], *J. M. Miller*[2], *A. C. Fabian*[1]

[1]Institute of Astronomy, Madingley Road, Cambridge, UK
[2]Department of Astronomy, University of Michigan, Ann Arbor, USA

The geometry of the accretion flow in the low/hard state (LHS) is a topic of much debate. A cool accretion disk is usually invoked in all interpretations, however the extent of its inner radius differs significantly between them. Either the geometrically thin disk in the LHS extends close to the inner most stable circular orbit or is truncated far from the black hole. This issue is verifiable using high quality X-ray data.

Here we present a comprehensive study of such systems in the low/hard state and argue that the accretion disk in these systems is not truncated far from the central black hole. Furthermore, we show that in the cases where the physical parameters of the system (mass, distance and inclination) are constrained the accretion disk is likely to be within 10 gravitational radii and consistent with extending to the innermost stable circular orbit in the canonical low/hard state.

Rapid timing studies of black hole binaries in Optical and X-rays: correlated and non-linear variability

P. Gandhi[1], *V.S. Dhillon*[2], *M. Durant*[3], *A.C. Fabian*[4], *K. Makishima*[1,5], *T.R. Marsh*[6], *J.M. Miller*[7], *T. Shahbaz*[3] *& H.C. Spruit*[8]

[1]RIKEN Cosmic Radiation Laboratory, 2-1 Hirosawa, Wako, Saitama 351-0198 Japan
[2]Department of Physics and Astronomy, University of Sheffield, Sheffield S3 7RH, UK
[3]Instituto de Astrofísica de Canarias, La Laguna, E38205 Tenerife, Spain
[4]Institute of Astronomy, Madingley Road, Cambridge, CB3 0HA, UK
[5]Department of Physics, University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113-0033, Japan
[6]Department of Physics, University of Warwick, Gibbet Hill Road, Coventry, CV4 7AL, UK
[7]Department of Astronomy, University of Michigan, 500 Church Street, Ann Arbor, MI 48109, USA
[7]Max-Planck-Institut für Astrophysik, Postfach 1317, 85741 Garching bei München, Germany

In one of the fastest multi-wavelength timing studies of black hole X-ray binaries (BHBs) to date, we have discovered correlated optical and X-ray variability in the low/hard state of two sources: GX 339-4 and SWIFT J1753.5-0127. After XTE J1118+480, these are the only BHBs currently known to show rapid (sub-second) aperiodic optical flickering. Our simultaneous VLT/Ultracam and RXTE/PCA data reveal intriguing behaviour when cross-correlating the optical and X-ray light curves, with characteristic peaks, dips and lags down to very short timescales (<~150 ms). Reprocessing can be ruled out as the origin of the aperiodic optical power in both sources. Instead, the variability may be driven by synchrotron emission from the inner accretion flow regions. A model with fast interactions between the disk, jet and corona can explain the complex correlation patterns. We also show that both the optical and X-ray lightcurves are intrinsically non-linear, in the sense that the absolute source variability r.m.s. amplitude linearly increases with flux, and that the flares have a log-normal distribution. The implication is that variability at both wavelengths is not due to local fluctuations alone, but rather arises as a result of coupling of perturbations over a wide range of radii and timescales. These 'optical and X-ray rms-flux relations' thus provide new constraints to connect the outer disk with the inner hot flow and jet.

The Ultraluminous State

T.P. Roberts[(1)], *J.C. Gladstone*[(1)], *L.M. Heil*[(2)], *C. Done*[(1)] *& S. Vaughan*[(2)]

[(1)]Dept of Physics, Durham University, South Road, Durham DH1 3LE, United Kingdom
[(2)]X-ray & Observational Astronomy Group, Dept of Physics & Astronomy, University of Leicester, University Road, Leicester LE1 7RH, United Kingdom

Although a great deal of progress has been made towards understanding the nature of ultraluminous X-ray sources (ULXs) over the past decade, many basic issues remain to be settled. Chief amongst these is the mass of the accretor in these systems: what proportion of ULXs are powered by accretion onto an intermediate-mass black hole (IMBH), and how big are these objects? Or can we explain their extraordinary X-ray luminosities by exotic, extreme accretion rate processes onto more prosaic stellar-mass black holes? Here we report the results of two new studies using the best available *XMM-Newton* observations to probe the astrophysics of ULXs. A systematic study of ULX power spectra shows a significant proportion of luminous objects with unusually suppressed variability compared to standard black hole binaries and AGN. Furthermore, detailed spectral studies confirm that ULX spectra appear unlike any standard accretion state in the *XMM-Newton* band pass. Hence we infer that many *ULXs contain small black holes operating in a new, super-Eddington "ultraluminous" accretion state*. We demonstrate that ULX spectra appear to vary with accretion rate, being closest to standard states at around Eddington, with an optically thick corona becoming the characteristic feature as we reach super-Eddington rates. At the highest rates we see evidence for the emergence of a cool photosphere, likely related to a massive outflowing wind.

Jet power and feedback from the “SS433-like” microquasar in NGC7793

M. Pakull[(1)], *R. Soria*[(2)]

[(1)]Strasbourg Observatory, UMR 7550 CNRS, 11 rue de l'Université, 67000 Strasbourg, France
[(2)]MSSL, University College London, Holmbury St Mary, RH5 6NT, United Kingdom

We have discovered an exceptional radio/optical/X-ray microquasar in the Sculptor galaxy NGC 7793 (distance of 3.4 Mpc), with a large (300 x 150 pc) shock-ionized H II and He III bubble, diffuse X-ray emitting gas, an X-ray core (with a hard power-law spectrum) near the centre of the nebula, and X-ray hot spots (with a thermal spectrum) where the collimated jet hits the interstellar medium. The radio synchrotron nebula has a similar size as the H-alpha and X-ray structures; it is more luminous (and of course much larger) than the Cas A supernova remnant in our Galaxy. The whole system resembles the famous Galactic microquasar SS433/W50, but on an even grander scale. From the X-ray luminosity of the hot spots, we estimate a power ~ 1E39 erg/s in the collimated jets (two orders of magnitude higher than the current X-ray luminosity of the core); from the large optical nebula, we estimate a mechanical power of almost 1E40 erg/s. Further radio campaigns are ongoing. We use this system to study black hole feedback onto the interstellar medium.

Galactic Compact Objects

Posters

ChIcAGO: Chasing the Identification of *ASCA* Galactic Objects

G. E. Anderson[(1)], *B. M. Gaensler*[(1)], *P. O. Slane*[(2)], *D. L. Kaplan*[(3)], *B. Posselt*[(2)], *S. S. Murray*[(2)] *and the ChIcAGO Team*

[(1)]Sydney Institute for Astronomy, School of Physics, The University of Sydney, NSW 2006, Australia
[(2)]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA
[(3)]Kavli Institute for Theoretical Physics, University of California, Santa Barbara, CA 93106, USA

We introduce the "ChIcAGO" (Chasing the Identification of *ASCA* Galactic Objects) survey, designed to identify the unknown X-ray sources discovered during the *ASCA* Galactic Plane Survey. *ASCA* surveyed the inner region of the Galactic plane (-45°≤ l ≤ 63° and $|b|$ ≤ 0°.4) in the energy band 0.7−10 keV, resulting in a catalogue of 163 sources. Unfortunately the poor angular resolution of these observations prevented the identification of most of the sources detected. Little is known about these objects, especially those that emit primarily in hard X-rays (2−10 keV). In ChIcAGO, we are using short *Chandra* observations to provide sub-arcsecond localizations for all these unidentified *ASCA* sources. This is followed by a multi-wavelength analysis of archival data, recent surveys, and new observations, through which we then identify and classify each target. We here present our first survey results and identifications from this effort. When completed, ChIcAGO will provide a new understanding of the distributions, birth rates and evolution of Galactic X-ray sources, with a particular focus on the progenitors and products of core-collapse.

Constraining compactness and magnetic field geometry of X-ray pulsars using pulse profile statistics

M. Annala, *J. Poutanen*

Astronomy Division, Department of Physical Sciences, P.O. Box 3000, FIN-90014 University of Oulu, Oulu, Finland

We study the statistics of pulse profiles of 138 X-ray pulsars, which are mainly in high-mass X-ray binary systems, in order to constrain the neutron star compactness and the magnetic geometry. The X-ray pulse profiles are classified according to the number of pulses seen during one period, dividing them into two classes, single- and double-peaked. The relative amount of pulsars in these classes is compared with the probabilities predicted by the theoretical model assuming different types of pencil-beam patterns.

Our results show that statistics of pulse profile does not allow to constrain compactness of the neutron stars. Also in contrast to the previous claims made by Bulik et al. (2003), the data do not require the magnetic inclination to be confined in a narrow interval but instead the magnetic dipole can have arbitrary inclination to the rotational axis. The observed amounts of different types of light curves can be explained by taking into account the X-ray detectors sensitivity to detect smallpulses, (i.e. detection threshold), which lowers the amount of observed double-peaked light curves.

Nonperiodic X-ray variability of LMXBs accretion disks

V. Arefiev

Space Research Institute, Profsoyuznaya str. 84/32, Moscow, Russia

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

3D MHD Simulations of accreting neutron stars: evidence of QPO emission from the surface

M. Bachetti[(1)], *M. Romanova*[(2)], *L. Burderi*[(1)], *A. Kulkarni*[(2)], *T. di Salvo*[(3)]

[(1)]INAF/Università degli Studi di Cagliari
[(2)]Cornell University, Ithaca NY
[(3)]Dipartimento di Scienze Fisiche ed Astronomiche, Università di Palermo

3D Magnetohydrodynamic simulations show (see for example Romanova et al. 2004) that when matter accretes onto neutron stars, in particular if the misalignment angle is small, it does not constantly fall at a fixed spot. Instead, the location at which matter reaches the star moves. These movements can be produced both during stable accretion, in which matter falls near the magnetic poles of the star, and unstable accretion, characterized by the presence of several tongues of matter which fall on the star near the equator, due to Rayleigh-Taylor instabilities. Analysis of lightcurves obtained in 3D MHD simulations show that those movements could be observed as high frequency Quasi Periodic Oscillations (see Romanova & Kulkarni 2008). We performed a number of new simulation runs with a much wider set of parameters, focusing on neutron stars with a small misalignment angle. In most cases we observe high-frequency oscillations whose frequency is correlated with the mass accretion rate. Moreover, in some cases double QPOs appear, each of them showing the same correlation with the mass accretion rate. We project the emission patterns observed in relatively short 3D simulations to longer-lasting Monte Carlo-produced time series modeled as RXTE observations, whose FFTs show QPOs similar to the ones observed in the spectra of real accreting neutron stars.

Frequency Resolved Spectroscopy of Selected Dipping Low-Mass X-ray Binaries

S. Balman

Middle East Technical University, Ankara, Turkey

Some galactic low-mass X-ray binaries (LMXBs) show periodic dips in their X-ray intensity as a result of obscuration by a structure in the outer regions of the disk. In order to further our knowledge on the emitting and absorbing regions in these systems over the X-ray wavelengths, frequency resolved spectroscopy (FRS) using the XMM-Newton data have been applied. We find that variability spectra shows differences in these systems as to emitting regions and geometry. EXO 0748-676 reveals different variable regions found in different states with spectral hardening as the frequency increases showing similar FRS behavior to Z-sources. A disk blackbody emission component of 0.14 keV is found in the high state and it disappears at higher frequencies as expected. In the low state FRS (0.05-50 Hz) is independent of Fourier frequency and shows a flouresence Fe line at 4.3-5.5 keV with large equivalent widths not function of Fourier frequency indicative of reflection component in the system. XB 1323-62 shows a power law emission along with a flourescence Fe line at 6.4-6.6 keV in the 0.9-30 Hz range indicative of reflection onto the disk surface. This source also shows 1.2-1.6 keV blackbody emission in the 0.002-0.3 Hz and 64-300 Hz ranges which we interpret as emission from a boundary layer. We will also discuss the FRS of 4U 1746-371 and X 1254-69 with luminosities (L) in excess of logL=37 in comparison to the other two lower L sources.

Orbital and Spin Phase Resolved Spectroscopy of the Intermediate Polar EX HYA

S. Balman , *Y. Pekon*

Middle East Technical University, Ankara, Turkey

We present for the first time orbital phase resolved spectra of an intermediate polar (IP), EX Hya, together with the spin phase resolved spectra during two different states with a factor of 63 difference between the X-ray fluxes. We used a model of neutral hydrogen columndensity with a covering fraction together with a cooling-flow model of plasma emission. We detect the same hot plasma in spin phase minimum and maximum with a temperature distribution of T_min at about 0.2 keV to a T_max of 23 keV for the lower state. The absorption (by a factor of 7) and covering fraction (by a factor of 3) increases from spin maximum to minimum. In the high state, the absorption difference between spin maximum and spin minimum is a factor of 6 and the covering fraction is almost the same. However, the hot plasma detected in the cooling flow model have different distributions 0.1-45 keV in spin maximum and 0.2-63 keV in spin minimum which shows that spin minimum is much harder in spectral characteristic. This indicates an extra ionized absorber at work in the high state. For the first time in an IP, we investigated orbital phase resolved spectra in order to understand the origin of orbital variations. We used a power law distribution of neutral column density of hydrogen with the same cooling flow model to fit spectra. We find no absorption difference between the orbital phase minimum and maximum in the low state. However, the hot plasma temperature distribution range from 0.8-26 keV for orbital maximum and 0.7-45 keV for orbital minimum. Thus, the low state orbital modulations are not due to cold absorption but either due to an ionized absorber and/or due to energy independent scattering in the system off of a structure fixed in the orbital plane since the minimum spectrum is harder than the maximum spectrum. In the high state, the cold absorption increases by a factor of 4 from orbital maximum to minimum. Moreover, the low temperature to high temperature range of the hot plasma is 0.6-27 keV in the orbital maximum and it changes to 2.2-68 keV in the orbital minimum. This is also a clear indication of spectral hardening and indication of ionized absorbers that are at work. A changing bulge size at the accretion impact zone togther with its changing ionization state can explain these spectral variations in a way that could be similar to low-mass X-ray binaries.

Suzaku/INTEGRAL observations of IGR 16318-4848

L. Barragán[1,2], *J. Wilms*[1,2], *K. Pottschmidt*[3,4], *M. A. Nowak*[5], *I. Kreykenbohm*[1,2], *R. Walter*[6], *J. A. Tomsick*[7]

[1]Dr. Karl Remeis-Sternwarte, Friedrich-Alexander-Universität Erlangen-Nürnberg, Sternwartstraße 7, 96049 Bamberg, Germany
[2]Erlangen Centre for Astroparticle Physics, Erwin-Rommel-Straße 1, 91058 Erlangen, Germany
[3]CRESST, University of Maryland Baltimore County, 1000 Hilltop Circle, Baltimore, MD 21250, USA
[4]NASA Goddard Space Flight Center, Astrophysics Science Division, Code 661, Greenbelt, MD 20771, USA
[5]MIT Kavli Institute for Astrophysics and Space Research, 77, Massachusetts Avenue, 37-241, Cambridge, MA 02139, USA
[6]INTEGRAL Science Data Centre, Geneva Observatory, University of Geneva, Chemin d'Écogia 16, 1290 Versoix, Switzerland
[7]Space Sciences Laboratory, University of California Berkeley, 7 Gauss Way, Berkeley, CA 94720-7450, USA

IGR J16318-4848 is the first example of a new class of highly absorbed X-ray binaries that has been discovered by INTEGRAL. We present results from the first simultaneous Suzaku/INTEGRAL observation of this source. The X-ray spectrum can be well described by an absorbed cutoff powerlaw, plus emission lines (Fe K_{α}, Fe K_{β}, and Ni K_{α}). The spectral characteristics of the source suggest a neutron star as the compact object in the binary system. The spectrum also shows a soft excess below 5 keV, which is probably due to a contaminating source (Ibarra et al., 2007). We compare the results of our fits with Monte Carlo simulations for the photoabsorption and Compton scattering in order to understand better the geometry of the absorber, and the shape of the lines (for which no Compton shoulder is detected).

The lightcurve varies significantly in hours; however the source remains always in a hard state, with very slight changes on the hardness ratio. The considerable variability of the source can be explained as being due to variations in NH.

A Multiwavelength Analysis of the Accretion Disk Corona in 4U 1822-371

A. J. Bayless[(1)], *E. L. Robinson*[(1)], *R. I. Hynes*[(2)], *T. Ashcraft*[(2)], *M. E. Cornell*[(1)]

[(1)]University of Texas at Austin, Dept. of Astronomy, 1 University Sta, Austin, Texas, 78712, USA
[(2)]Louisiana State University, Dept. of Physics and Astronomy, Baton Rouge, LA, 70803, USA

We present new observations and analysis of the low-mass X-ray binary (LMXB) 4U 1822-371. This LMXB is unusual in that the luminosity ratio Lx/Lopt ~ 20, while in normal LMXBs this ratio is a few hundred. 4U 1822-371 has an accretion disk corona (ADC) that scatters X-ray photons from the inner disk and neutron star out of the line of sight. 4U 1822-371 has a high orbital inclination and the secondary star eclipses the disk and ADC.

We have obtained new time-resolved UV spectrograms with the ACS/SBC on HST in addition to V- and J-band photometry with the 1.3-m SMARTS telescope at CTIO. The large quadratic term in our new optical eclipse ephemeris confirms that the system has an extremely high rate of mass transfer and mass accretion. The C IV λλ1548-1550Å emission line has a half width of ~4000 km/s, indicating a strong, high velocity wind is being driven off the accretion disk. We show that the ADC has an optically thick photosphere in UV, V, and J. The eclipse analysis shows that in V and J the ADC extends nearly to the outer edge of the disk with the radius in the UV being slightly smaller. The ADC must also extend vertically in all bandpasses to a height equal to approximately half the disk radius. This “optical ADC” is likely the optically thick base of a high velocity disk wind.

Properties of a fast state transition in Cygnus X-1

M. Boeck [1], *J. Wilms*[1], *M. Hanke*[1], *S. Pirner*[1], *V. Grinberg*[1,2], *K. Pottschmidt*[3,4], *S. Markoff*[2], *M.A. Nowak*[5], *G.G. Pooley*[6]

[1]Dr. Karl Remeis-Sternwarte and Erlangen Centre for Astroparticle Physics, Bamberg, Germany
[2]Astronomical Institute ``Anton Pannekoek'', University of Amsterdam, NL
[3]CRESST and NASA Goddard Space Flight Center, Greenbelt, MD, USA
[4]Center for Space Science and Technology, University of Maryland, Baltimore County, Baltimore, USA
[5]Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology, Cambridge, MA, USA
[6]Cavendish Laboratory, University of Cambridge, Cambridge, UK

In 2005 February we observed the microquasar Cygnus X-1 for a total of 10 days quasi-continuously with the Rossi X-ray Timing Explorer and the Ryle telescope. During that period of time Cyg X-1 was in an intermediate state and thus very variable. It covered a large fraction of its total variability found during our years long monitoring. As a highlight a full transition from the hard to the soft state occurred within less than three hours. We present results of the spectral and timing analysis including the evolution of the time lags and the coherence function, compare them with the long-term behavior and discuss the discovered energy dependence of the power spectra.

Timing of the 2008 Outburst of SAX J1808.4-3658 with XMM-Newton: a Stable Orbital Period Derivative over Ten Years

L. Burderi, A. Papitto, A. Riggio[(1)]*,M. T. Menna*[(2)]*, T. Di Salvo, A. D'Aì, R. Iaria*[(3)]

[(1)]Dipartimento di Fisica, Universita' degli Studi di Cagliari, SP Monserrato-Sestu, KM 0.7, 09042 Monserrato, Italy
[(2)]INAF - Osservatorio Astronomico di Roma, via Frascati 33, 00040 Monteporzio Catone, Italy
[(3)]Dipartimento di Scienze Fisiche ed Astronomiche, Universita' degli Studi di Palermo, via Archirafi 36 - 90123 Palermo, Italy

We report on a timing analysis performed on a 62-ks long XMM-Newton observation of the accreting millisecond pulsar SAX J1808.4-3658 during the latest X-ray outburst that started on September 21, 2008. By connecting the time of arrivals of the pulses observed during the XMM observation, we derived the best-fit orbital solution and a best-fit value of the spin period for the 2008 outburst. Comparing this new set of orbital parameters and, in particular, the value of the time of ascending-node passage with the orbital parameters derived for the previous four X-ray outbursts of SAX J1808.4-3658 observed by the PCA on board RXTE, we find an updated value of the orbital period derivative, which turns out to be $\dot{P}_{orb}= (3.89 \pm 0.15) \times 10^{-12}$ s/s. This new value of the orbital period derivative agrees with the previously reported value, demonstrating that the orbital period derivative in this source has remained stable over the past ten years. Although this timespan is not sufficient yet for confirming the secular evolution of the system, we again propose an explanation of this behavior in terms of a highly non-conservative mass transfer in this system, where the accreted mass (as derived from the X-ray luminosity during outbursts) accounts for a mere 1% of the mass lost by the companion.

Deriving an unbiased X-ray luminosity function of dwarf novae

K. Byckling[(1)], *K. Mukai*[(2)], *J. Thorstensen*[(3)], *J. Osborne*[(1)]

[(1)]University of Leicester, University Road, Leicester, LE1 7RH, UK
[(2)]NASA/GSFC, Greenbelt, MD 20771, USA
[(3)]Department of Physics and Astronomy, 6127 Wilder Laboratory, Dartmouth College, Hanover, NH 03755-3528, USA

Dwarf novae (DNe), are a subclass of cataclysmic variables (CVs), in which the white dwarf accretes material from a late-type dwarf forming an accretion disc around the white dwarf. From time to time the disc switches from its quiescent state (low brightness) to an outburst state (high brightness). DNe, while less X-ray luminous than magnetic CVs, are the most numerous CV type in the Galaxy. Current measurements of the X-ray luminosity function of dwarf novae contain biases due to high X-ray flux sources. Therefore, we have measured luminosities of 12 DNe in their quiescent state (recently obtained observations of 7 Suzaku sources which have not previously been the targets of pointed imaging observations in the 2-10 keV band and 5 archival XMM sources) with the aim of building up a more reliable X-ray luminosity function. In order to obtain accurate luminosities, we have chosen only those sources which have a parallax-based distance estimate of less than 200 pc. We will present the results of our analysis and discuss the implications.

H1743-322: comparing the latest outbursts

F. Capitanio, et al.

IASF-Roma INAF

H1743-322 is a bright BHC observed by HEAO-1 in 1977. The source underwent again an outburst after 25 years on March 2003 and after this brightest outburst (60 mCrab between 15-40 keV) , it also had three fainter outbursts on September 2004, September 2005 and January 2008. These three outbursts followed the typical spectral evolution of a BHC: starting from Low Hard state , evolving through the Hard and the Soft Intermediate States to the High Soft State and then back to the low Hard state. However in October 2008 a the source underwent again in outburst. During the entire duration of this outburst only two states were sampled: the LHS and the HIMS. This is a rare characteristic for a transient BHC.

We present here the results of the RXTE and INTEGRAL timing and spectral analysis of the H1743-322 latest outburst compared with the previous ones, showing that the evolution of a BHC outburst, through the different spectral states, is still difficult to predict.

Geminga, Fermi and consequences

P.A. Caraveo[1], *G.F. Bignami* [1,2], *A. De Luca*[1,2]

[1]IASF-INAF, Via Bassini, 15, Milano, Italy
[2]USS Pavia, Italy

The Fermi LAT is showing that the majority of the UGOs are, in fact, Gemingas. There are currently roughly as many gamma-ray radio-quiet NSs as gamma-ray radio-loud pulsars. After 30 years, another mistery, that of UGOs, is crumbling.
We'll explore the consequences for NSs, for the Galaxy and for gamma-ray astronomy.

Magnetic accreting white dwarfs in the XMM-Newton era

D. de Martino, et al.

INAF-Capdimonte Astronomical Observatory, Salita Moiariello 16, Naples, Italy

Among Cataclysmic Variables (CVs) the magnetic systems are the brightest X-ray sources, representing 25% of the whole class. These accreting white dwarf binaries were recently found to constitute a non-negligible fraction of galactic hard (>20keV) X-ray sources suggesting a still hidden but potentially important population. XMM-Newton has allowed to identify the true nature of many newly discovered CV candidates and to infer unexpected X-ray temporal and spectral properties of magnetic systems and their link with fundamental parameters of the accreting primaries. A review of these results will be presented, including the importance of UV/optical coverage, as well as future perspectives to understand the role of this class of X-ray sources in galactic studies.

Observations of Very Faint X-ray Binaries

M. Del Santo

INAF/IASF-Roma, via del Fosso del Cavaliere 100, Roma. Italy

The improvement of sensitivity of the last generation of X-ray detectors makes a significant number of very faint X-ray binaries with typical luminosities of 1E34-1E36 erg/s to be detectable. Faint X-ray binaries, either transients (VFXT) or persistent, are probably a non-homogeneous class of sources. It has been proposed that a consistent number should be X-ray binaries with Neutron Star as compact object, exhibiting type-I X-ray bursts with long recurrence time.

INTEGRAL unveiled the nature of two transient bursters: XMMU J174716.1-281048 and AX J1754.2-2754. We classified XMMU J174716.1-281048 as "quasi-persistent" source due to the evidence of a prolonged accretion episode of many years at low Mdot. In the framework of the INTEGRAL Key-Programme, we have data rights of a sample of faint X-ray binaries, being in the Galactic Centre and Galactic Plane. INTEGRAL offers the ``chance" to catch new type-I X-ray bursts from VFXTs, as well as to detect faint hard-X ray persistent emission at a level of few mCrab. Combining multi-wavelength follow-up (mainly with Swift), we have the possibility to characterise the sub-luminous accreting NS systems. I will review the main observational properties of the class of the very faint X-ray binaries, in particular transient sources, and present results from INTEGRAL key-programme and Swift ToO monitoring campaign.

The variability of the warm absorber in the hybrid LMXB GX13+1

M. Diaz Trigo (1)*L. Sidoli* (2)*, A. Parmar* (3)*, L. Boirin*(4)

(1)ESAC, Spain
(2)INAF Milano, Italy
(3)ESTEC, The Netherlands
(4)Observatoire de Strasbourg, France

We report on five recent XMM-Newton observations of the neutron star low-mass X-ray binary (LMXB) GX13+1. GX 13+1 spectra show strong narrow absorption features of Fe XXV and Fe XXVI, a signature of a disk outflowing wind. Observations with a hard spectrum, with high temperatures for the blackbody (kT ~ 1.6 keV) and disc blackbody (kT ~ 1.1 keV) and inner disc radii in the range 16-21 km, show a very ionised absorber, with only absorption due to Fe XXVI, and a modest emission Gaussian, with an equivalent width of ~70 eV. In contrast, observations with softer spectra, with a colder blackbody (kT ~ 1.2 keV) and disc blackbody (kT ~ 0.75 keV) and inner disc radii in the range 26-42 km, show a cooler absorber, with Fe XXV and Fe XXVI aborption, and a stronger emission Gaussian, with an equivalent width of ~180 eV. This analysis reveals a direct relation between the disc radius, the ionisation state of outflow and the strength and ionisation of the iron emission line. In one observation we detect a decrease of the average count rate by more than 80% associated with spectral hardening. This is typical of dipping behaviour. The detection of dipping behaviour determines the inclination of the binary to be >70 degrees.

Highly magnetized neutron star in GX 301-2

V. Doroshenko[(1)], *A. Santangelo*[(1)], *V. Suleimanov*[(1)], *I. Kreykenbohm*[(2,4)], *C. Ferrigno*[(1,3)], *R. Staubert*[(1)], *D. Klochkov*[(1)]

[(1)]Institut für Astronomie und Astrophysik, Sand 1, 72076 Tübingen, Germany
[(2)]Dr. Karl Remeis-Sternwarte, Sternwartstrasse 7, 96049 Bamberg, Germany
[(3)]ISDC Data Centre for Astrophysics, Chemin d'Écogia 16, CH-1290 Versoix, Switzerland
[(4)]Erlangen Centre for Astroparticle Physics (ECAP), Erwin-Rommel-Strasse 1, 91058 Erlangen, Germany

The rather long spin period, P_{spin}~680 s, of GX 301-2 can be explained in the framework of existing torque models for neutron stars only if the magnetic field at the surface of the star is $B \sim 10^{14}$ G under the assumption of torque equivalence. Analysis of the pulse period history using BATSE data reveals that the latter is indeed the case. We discuss therefore a scenario in which the neutron star is highly magnetized. In our model, the apparent contradiction between this assumption and the field measured through cyclotron resonance scattering $B \sim 3 \cdot 10^{12}$ G, is resolved by assuming that the cyclotron line is formed in an accretion column of a height comparable to the neutron star radius. We show also that spectral results based on INTEGRAL data are coherently explained in this scenario.

SGR 1627-41's Return

P. Esposito, D. Götz, G. L. Israel, S. Mereghetti, N. Rea, P. Romano, A. Tiengo, R. Turolla, S. Zane

INAF-IASF Milano, via E. Bassini 15, 20133 Milano, Italy

Two small classes of young isolated neutron stars, the anomalous X-ray pulsars and the soft gamma-ray repeaters, are currently believed to host magnetars, e.g. neutron stars endowed with ultra-strong magnetic field, $B>10^{14}$-10^{15} G on the surface. After nearly a decade of quiescence, the soft gamma-ray repeater SGR 1627-41 awakened on 2008 May 28 with a bursting episode followed by a slowly-decaying enhancement of its persistent emission. Here we report on Swift and XMM-Newton observations that allowed us to study the flux and spectral evolution of the source through the period 2008 February-September, which includes the spectacular outburst. In particular, we focus on the 2008 September XMM observation that led, among others, to the discovery of the pulsation period of this source, the only known magnetar for which this key piece of information was still missing. This deep XMM observation also unveiled diffuse X-ray emission surrounding SGR 1627-41, which is likely associated to the young supernova remnant G337.0-0.1.

ESA INTEGRAL results on cataclysmic variables

R. Hudec[1,2], *V. Simon*[1,2], *M. Kocka*[1,2], *L. Hudec*[1,2]

[1]Astronomical Institute, CZ-251 65 Ondrejov, Czech Republic
[2]ISDC, Versoix, Switzerland

ESA INTEGRAL satellite proved to be an efficient tool to study hard X-ray emission of many types of astrophysical objects. In this talk, we will focus on results of observations of cataclysmic variables.

Identification and investigation of high-energy sources with Astronomical Archival Plates

R. Hudec[1,2]

[1]Astronomical Institute, CZ-251 65 Ondrejov, Czech Republic
[2]Czech Technical University, Prague, Czech Republic

The ESA INTEGRAL satellite (International Gamma Ray Laboratory) launched in October 2002 continues to deliver valuable data about the gamma-ray sky. Hundreds gamma-ray sources were detected so far mainly by the IBIS onboard instrument, and others are expected in the future. Identification (and consequent analyse) of the sources is important but not easy task. We discuss alternative method based on astronomical archival plates. We show that The Sonneberg Field Patrol and Leiden/Johannesburg Franklin Adams Plates represent suitable database for identification and analysis of INTEGRAL sources. They both provide numerous data for regions along the Galactic Plane and in the Galactic Center. Examples of gamma-ray Examples of INTEGRAL and high-energy sources studied on astronomical archival plates will be shown. In addition the capabilities of astronomical plate archives in study of high-energy sources in general will be discussed together with recent digitizaion efforts.

Evolution in recycling scenario

M. N. Iacolina[(1)], *L. Burderi*[(1)], *M. Burgay*[(2)], *A. Possenti*[(2)], *T. Di Salvo*[(3)]

[(1)]Università di Cagliari, Dipartimento di Fisica, SP Monserrato-Sestu km 0.7, 09042 Monserrato (CA), Italy
[(2)]INAF-Osservatorio Astronomico di Cagliari, Loc. Poggio dei Pini, Strada 54, 09012 Capoterra (CA), Italy
[(3)]Università di Palermo, Dipartimento di Scienze Fisiche ed Astronomiche, via Archirafi 36, 90123 Palermo, Italy

The recycling model argues the existence of an evolutionary connection between low-mass X-ray binaries and radio millisecond pulsars, during which the neutron star undergoes accretion of matter and angular momentum from the companion star until it reaches the mass-shedding spin period, whose value depends on the neutron star equation of state, and is in most cases below one millisecond.

However, two main facts should be noted: (a) the minimum observed spin periods are significantly longer than the critical limit for mass-shedding of the neutron star at its equator for most equation of state, which would indicate either very hard equations of state or that some other mechanism is responsible for the spin limit; (b) the mass accreted onto the neutron star during the low-mass X-ray binary phase is large enough to overcome the maximum mass allowed for a neutron star, implying a collapse into a black hole.

By this work we will show how the onset of the *radio-ejection* is able to overcome these problems within the recycling scenario. In fact we assert that, during the accretion phase, the balance between the pression of the accreting matter and the radiation pressure of the rotating magneto-dipole determines a critic orbital period above which the accretion of matter is inhibited by the pulsar radiation pressure, determining in this way a limit on the spin-up and on the accreted mass onto the neutron star.

Relativistic signatures observed in GX 349+2 with XMM-Newton

R. Iaria, A. D'Aì, T. Di Salvo, N. R. Robba

DSFA-Universita' di Palermo, via Archirafi 36, Palermo, Italy

The broad emission features in the Fe-Ka region of X-ray binary spectra represent an invaluable probe to constrain the geometry and the physics of these systems. Several Low Mass X-ray binary systems (LMXBs) containing a neutron star (NS) show broad emission features between 6 and 7 keV and most of them are now interpreted as reflection features from the inner part of an accretion disk in analogy to those observed in the spectra of X-ray binary systems containing a Black Hole candidate.

The NS LMXB GX 349+2 was observed by the XMM-Newton in the 0.7-10 keV energy range, The continuum emission is modelled by a blackbody component plus a multicoloured disk blackbody. In the residuals five prominent broad emission features are present at 1, 2.62, 3.32, 3.9 and 6.7 keV respectively, which can be equivalently well fitted with Gaussian profiles or relativistic smeared lines (diskline in XSPEC) we find that the reflecting plasma is located at a distance less than 50 km from the NS, a value compatible with the inner radius of the accretion disk inferred from the multicolored disk blackbody component (24 km). The inclination angle of GX 349+2 is between 39 and 42 deg., theemissivity index of the primary emission is between -2.2 and -1.9.

Spectral variability of ultraluminous X-ray sources

J. J. E. Kajava, *J. Poutanen*

University of Oulu, Department of Physical Sciences, P.O.Box 3000 90014 University of Oulu, Oulu, Finland

We study spectral variability of ultraluminous X-ray sources (ULX) using archived XMM-Newton and Chandra observations. We use three models to describe the observed spectra: a power-law, a multi-colour disc (MCD) and a combination of these two models. We find that out of the 11 ULXs in our sample, 7 ULXs show a correlation between the luminosity (L) and the photon index (Gamma). Furthermore, 4 out of these 7 ULXs also show spectral pivoting in the observed energy band. We also find that two ULX s show an L-Gamma anti-correlation. The spectra of 4 ULXs in the sample can be adequately fitted with a MCD model. We compare these sources to known black hole binaries (BHB) and find that they follow similar paths in their luminosity-temperature diagrams. Finally we show that the luminosity of the 'soft excess' (Lsoft) for the ULXs at temperatures T~ 0.2 keV seems to roughly proportional to (L_{soft} ~ $T^{-3.5}$) when modeled with a power-law plus a 'cool' MCD model. This is contrary to the luminosity-temperature relation that is expected from theory and what is seen for many accreting BHBs. We therefore reject the hypothesis that the 'soft excess' is a signature of an accretion disc around an intermediate mass black hole and propose that the observed L_{soft} ~ $T^{-3.5}$ trend could arise from disc emission beamed by an outflowing wind around a ~ 10 solar mass black hole.

Angular Momentum Accretion onto Neutron Stars in Wind-fed Binary Systems

S. Karino

JAD Program, unisel, block 4, Jalan Zirkon A7/A, Seksyen 7, 40000 Shah Alam, Selangor, Malaysia

In this study, we investigate accretion processes onto neutron stars (NSs) in High Mass X-ray Binaries (HMXBs). Especially, we focus on wind-accretion processes in systems with eccentric orbit. In these systems, accretion wind derivers not only mass but also angular momentum. The accreted angular momentum may affect rotational evolution of NS. Hence, we theoretically estimate the transportation efficiency in such wind-fed HMXB systems.

We propose a new interpretation of the observed spin periods in wind-fed HMXB. Namely, if we consider that these systems are just evolving toward equilibrium spin conditions, observed slow-rotation of NS can be naturally understood.

Also we confirm that accretion discs will not be formed in wind-fed systems, since the angular momentum transported from the stellar wind is moderately small. These results will not be changed even in eccentric systems.

Echoes' of the Kerr Metric: High Frequency QPOs in Due to Black Hole Spin

D. Kazanas, K. Fukumura

NASA/GSFC, Code 663, Greenbelt, MD 20771

We present detailed computations of photon orbits emitted by flares at the ISCO of accretion disks around rotating black holes. We show that for sufficiently large spin parameter, i.e. a > 0.94 M, flare a sufficient number of photons arrive at an observer after multiple orbits around the black hole, to produce an "photon echo" of constant lag, i.e. independent of the relative phase between the black hole and the observer, of T~14 M. This constant time delay, then, leads to a power spectrum with a QPO at a frequency nu~1/14M, even for a totally random ensemble of such flares. Observation of such a QPO will provide incontrovertible evidence for the high spin of the black hole and a very accurate, independent, measurement of its mass.

Long-term variability of Vela X-1

P. Kretschmar [(1)], *J. Keating*[(2)], *I. Kreykenbohm*[(3)], *F. Fürst*[(3)], *J. Wilms*[(3)], *R. Staubert*[(4)],

[(1)]ESA-ESAC, PO Box 78, 28691 Villanueva de la Cañada, Madrid, Spain
[(2)]University College Dublin, Belfield, Dublin 4, Ireland
[(3)]Dr. Karl-Remeis-Sternwarte, ECAP, Universität Erlangen-Nürnberg, 96049 Bamberg, Germany
[(4)]Institut für Astronomie und Astrophysik Tübingen, Sand 1, 72076 Tübingen, Germany

The archetypical wind-accreting X-ray pulsar Vela X-1 is known to be variable on a large range of timescales. Relatively tranquil phases exist as well as extended phases of high variability and flaring. We present results from a systematic study of variations with orbital phase and other timescales based on RXTE-ASM and Swift-BAT data.

Clumps in the stellar wind of Vela X-1

I. Kreykenbohm[1,2], *F. Fuerst*[1,2], *J. Wilms*[1,2], *P. Kretschmar*[3], *J. M. Torrejon*[4], *A. Santangelo*[5], *R. Staubert*[5]

[1]Dr. Karl Remeis-Sternwarte Bamberg
[2]Erlangen Centre for Astroparticle Physics, University of Erlangen-Nuremberg
[3]European Space Astronomy Centre, ESA, Madrid
[4]University of Alicante
[5]Kepler Center for Astro and Particle Physics, University of Tübingen

We present a detailed analysis of all public available INTEGRAL data of the High Mass X-ray Binary pulsar Vela X-1, in total more than 5.5 Msec. The source exhibited very active but also very quiet states. During the more active phases, Vela X-1 featured many bright flares with a maximum intensity of more than 5 Crab, but at the same time also offstates during which the source was undetectable by INTEGRAL/ISGRI. To study the flaring behavior, we performed a statistical analysis of the X-ray lightcurves in several energy bands from 20 keV up to 60 keV. The resulting log-normal distributions show that the source has typically an intensity level of about 300 mCrab, but the distributions also extend beyond 2 Crab. We interpret these flares and also the offstates as being a direct evidence for the strongly structured wind in Vela X-1: the accretion of a dense blob from the stellar wind by the neutron star results in a giant X-ray flare. Similarly the X-ray offstates are due to the neutron star entering a cavity of strongly reduced density in the wind. We therefore conclude that the X-ray intensity is a direct tracer for the mass accretion rate and thus also the mass of the clumps in the stellar wind is indeed log-normally distributed as predicted by line studies.

Monte-Carlo simulations of X-ray continuum of SS433

Yu.M. Krivosheyev[1], *G.S. Bisnovatyi-Kogan*[1,3], *A.M. Cherepashchuk*[2], *K.A. Postnov*[2]

[1]Space Research Institute of Russian Academy of Science (IKI), Profsoyuznaya 84/32, Moscow 117997, Russia
[2]Sternberg Astronomical Institute, Moscow State University, Universitetsky pr., 13, Moscow 119992, Russia
[3]Joint Institute for Nuclear Research, Joliot-Curie 6, Dubna 141980, Moscow region, Russia

SS433 is a peculiar massive X-ray binary system with precessing relativistic jets. It is one of the brightest stars in the Galaxy, the bolometric luminosity of the object assuming isotropic radiation is $L_{bol} \sim 10^{40}$ erg/s. The uniqueness of this source comes from existence of narrow oppositely directed subrelativistic jets, which emit red and blue-shifted, periodically variable lines. A commonly accepted model of this object suggests that a continuous regime of supercritical accretion of gas onto the relativistic star is maintained.

We will concentrate on broad-band X-ray spectrum of SS433. In the last years the source was intensively observed by RXTE, XMM, Chandra and INTEGRAL. We have made use INTEGRAL observations of SS433 in May 2003 simultaneously by IBIS/ISGRI (20-100 keV) and JEM-X (3-20 keV) telescopes. Our purpose is to model the observed broad-band X-ray continuum of SS433 using accurate treatment of emission processes in the jet and scattering hot corona above the accretion disk with the aid of the Monte-Carlo method. We find out that the observed broadband X-ray continuum of SS433 is dominated by thermal emission of the jet and rarefied hot corona, with addition from the inverse Compton scattering on hot electrons of the corona. The emission from inner regions of the accretion disk also contributes to the spectrum, but mostly at energies below 1~keV.

The soft excess in low-luminosity X-ray pulsars

N. La Palombara, S. Mereghetti, L. Sidoli, P. Esposito, A. Tiengo

INAF – IASF Milano, Via E. Bassini 15, 20133 Milano (I)

The presence of a clear soft excess above the main power-law component is an almost ubiquitus feature in the spectra of X-ray binary pulsars. In most cases it can be described with a blackbody model which, in the high-luminosity sources ($L_X > 10^{36}$ erg/s) is usually characterized by low temperature (kT < 0.5 keV) and large emission radius (R > 100 km). In the latest years, thanks mainly to XMM-Newton observations, a blackbody excess has been observed also in low-luminosity and long-period (P > 100 s) pulsars. In particular three persistent, low luminosity Be/NS binary pulsars (4U 0352+309, RX J0146.9+6121 and RX J1037.5-5647) have a blackbody component with similar characteristics, i.e. a high temperature (kT > 1 keV) and a small radius (R < 500 m), very different from that observed in the higher luminosity sources. The derived blackbody radius is consistent with the expected dimensions of the neutron-star polar caps, suggesting that the soft excess might originate on the NS surface. Here report on the timing and spectral characteristics of these pulsars obtained with recent observations, and compare them to other sources with similar properties, showing that a high-temperature and small-size blackbody component is a very common feature of the low-luminosity and long-period pulsars.

A low luminosity state in the massive X-ray binary SAX J0635+0533

N. La Palombara, *S. Mereghetti*

INAF – IASF Milano, Via E. Bassini 15, 20133 Milano (I)

The source SAX J0635+0533, discovered in 1997 by BeppoSAX, contains a short period X-ray pulsar (P = 33.8 ms) and is positionally coincident with a Be star. If confirmed, this would be the fastest pulsar in a Be/neutron star binary. If the X-ray luminosity is powered by accretion, the neutron star magnetic field should be about three orders of magnitude smaller than expected in a typical high mass X-ray binary, in order to avoid the propeller effect. RXTE observations provided a lower limit on the spin-down rate (Pdot > 3.8×10^{-13} s/s), implying a large rotational energy loss and opening the possibility that the X-ray emission is rotation powered. Here we report on XMM-Newton satellite observations of SAX J0635+0533, which allowed us to improve the source localization, thus confirming the association with the Be star, and to carry out a spectral and timing analysis. SAX J0635+0533 was found, for the first time, in a low intensity state, a factor ~30 lower than that seen in all previous observations. We reconsider the possible scenarios to explain this peculiar source in the light of the small and variable luminosity ($<3 \times 10^{32}$ - 3×10^{33} erg/s) observed with XMM-Newton.

The latest outburst of IGR J16479-4514 as seen by Swift

V. La Parola[1], *L. Ducci*[2], *P. Romano*[1], *L. Sidoli*[2], *G. Cusumano*[1], *S. Vercellone*[1], *V. Mangano*[1], *J. A. Kennea*[3], *H. A. Krimm*[4], *D. N. Burrows*[3], *and N. Gehrels*[4]

[1]INAF IASFPa, Via U. La Malfa 153, Palermo, Italy
[2]INAF IASF Milano, Italy
[3]Penn State University
[4]NASA Goddard Space Flight Center

IGR J16479-4514 is a member of the supergiant fast X-ray transient (SFXT) class, a subset of high-mass X-ray binaries, whose number is rapidly increasing thanks to the INTEGRAL observations of the Galactic plane. This source has been regularly monitored with Swift/XRT since November 2007 to study its properties as its flux varies.

We present the most updated light curves of this source and, in particular, the Swift/XRT observations of its latest outburst, which occurred on January 29, 2009. During this outburst, which we followed for over two weeks, IGR J16479-4514 showed prolonged activity lasting for several days.

X-ray wind tomography of IGR *J17252-3616*

A. Manousakis, *R. Walter*

ISDC Data Center for Astrophysics and Observatoire de Geneve, Switzerland

IGR *J17252-3616*, a highly absorbed High Mass X-ray Binary (HMXB) with Hydrogen column density N_H~(2-4) 10^{23} cm^{-2}, has been observed with XMM-Newton for about one month. Observations were scheduled in order to cover the orbital-phase space as much as possible. IGR *J17252-3616* shows a varying column density N_H and Fe Kα line when fit with simple phenomenological models. A refined orbital solution can be derived. Spectral timing analysis allows derivation of the wind properties of the massive star.

AGILE/GRID observation of the pulsar PSR J0614+2229, PSR J1826-1334 and PSR J1856+0113

T. Mineo[(1)], *R. Campana*[(2)], *S. Vercellone*[(1)]

[(1)]INAF-IASF-Palermo, Via U. La Malfa 153, 90146, Palermo, Italy
[(2)]INAF–IASF-Roma, Via Fosso del Cavaliere 100, 00133, Roma, Italy

We present the analysis of PSR J0614+2229, PSR J1826-1334, PSR J1856+0113 observed with AGILE/GRID. The sources are detected in the spatial analysis with high significance. However, folding the arrival times with contemporary radio ephemeris, no pulsed signal was detected. We discuss the association of the AGILE detections with the gamma emission from these pulsars, investigating also alternative candidates as low-energy counterparts.

**BeppoSAX observation of the microquasar GRS 1915+105:
spectral and timing behavior in the ro class**

T. Mineo, E. Massaro, G. Ventura, F. Massa, M. Feroci, G. Cusumano, P. Casella, T. Belloni, A. Segreto

INAF-IASFPa, Palermo (Italy)

BeppoSAX observed GRS 1915+105 on October 2000 with a long pointing lasting about 770 ks. During this observation the source was mainly in the ro class characterized by busts with recurrence time between 40 and 100 s.

Indication on the spectral behavior have been obtained from the rate variations vs time in four energy bands: 1.3-3 keV, 3-6 keV, 6-10 keV, 15-100 keV.

The average rate in the energy range 1.3-3 keV is remarkably similar to that in the 15-100 keV with two long states of different intensity, while in the intermediate energy range, the rate increases with a continuous almost linear trend.

In the poster, we present a detailed study of the spectral behavior of the average spectra accumulated during each satellite orbit and of the spectra relative to three main components of the burst light curve: the spectrum of the lower level, the spectrum of the time interval before the peaks and the spectrum of the peak.

Comparison of the results with models gives indication on the physics of the accretion disk surrounding this object.

High energy spectral evolution in GX 339-4 and the transient black-hole candidates: spectral changes and high-energy cutoff behaviour across an hard to soft state transition

S. Motta[(1,2),] *T. Belloni* [(1)]

[(1)]INAF-Osservatorio Astronomico di Brera, Via E. Bianchi 46, I-23807 Merate (LC), Italy;
[(2)]Università dell'Insubria, Via Valleggio 11, I-22100 Como, Italy

I present an x-ray spectral study performed on a few transient black-hole candidates observed with the RXTE satellite. I mainly focus on the analysis of broad band spectral evolution of the sources during their hard-to-soft state transition and in particular on the behaviour of the high-energy cut off.

I performed a detailed caracterization of the transient black-hole candidate GX 339-4 during its 2007 outburst based on timing and spectral analysis and described in terms of the pattern in an X-ray hardness-intensity diagram. The spectra, fitted with a simple model (powerlaw with a exponential high-energy cut off), indicate that the hard component steepened along the full transition from hard to soft state. The high-energy cut off decreases monotonically during the brightening of the hard state and increases during the following softening towards a softer state. It becomes undetectable when the source reaches the softest state. I used GX 339-4 as a term of comparison for other transient black-hole candidates and I foud that different sources showed a behaviour similar to GX 339-4: a non-monotoic evolution of the high-energy cut off and large spectral variations across the hard-to-soft transition observed.

The results I present constitute an important mesurement of the changes of the broad-band X-ray spectrum of some transient black-hole binaries across the hard-to-soft state transition. We still do not have a complete picture of the evolution of the hard spectral component during the hard-to-soft transition, though we acquired important new informations.

Globular Cluster X-ray Sources

D. Pooley

University of Wisconsin at Madison, 475 N Charter Street, Madison, WI, USA

I will report the preliminary results of two recent *Chandra* surveys which together resulted in new observations of 30 Galactic globular clusters. The aim of these observations is to probe in detail the overabundance of various classes of X-ray sources (low-mass X-ray binaries, cataclysmic variables, millisecond pulsars, and active main-sequence binaries) in globular clusters. The overabundance of low-mass X-ray binaries in outburst has long been known and is the result of the dynamical interactions unique to the dense stellar environs in globular clusters. Results from the early *Chandra* observations of globular clusters established that the entire low-mass X-ray binary population (including the low-luminosity quiescent systems) is overabundant, as is the cataclysmic variable population. When combined with previous *Chandra* observations, these two recent surveys will have uncovered over 90% of the dynamically formed X-ray source population in all Galactic globular clusters. This will be used as a powerful probe of the internal dynamics of globular clusters. In addition, these data will test the recent suggestion that we have misunderstood the dynamical states of globular clusters.

IR and Optical counterpart detection and classification of recently discovered X-ray sources in our Galaxy

E.M. Ratti [(1)], *C. Bassa* [(1)], *P.G. Jonker* [(1,2)], *M. Torres*[(2)], *L. Kuiper*[(1)]

[(1)]SRON, Netherlands Institute for Space research, Sorbonnelaan 2, 3584 CA, Utrecht, The Netherlands
[(2)]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street,Cambridge,MA 02138,USA

We have analysed X-ray multi-wavelength observations of a selection of 15 X-ray sources discovered over the last years by INTEGRAL or RXTE. We inferred the position of the X-ray sources from Chandra observations and we localized those on Optical and IR images (from Magellan, Blanco and NTT) with a precision of few tenths of arcseconds. Using the accurate astrometry we are able to identify the optical/IR counterpart. Combining the information we have in different wavelengths, we investigate the nature of the observed sources. We will discuss our results in the context of the various groups of X-ray sources such as supergiant fast X-ray transients, hard Cataclysmic Variables and (ultra-compact) low-mass X-ray binaries.

The Nature of the Accretion Flow in the Low-Hard State: Suzaku Observations of Swift J1753.5-0127

M. Reynolds[(1)], *J. Miller*[(1)], *J. Homan*[(2)], *G. Miniutti*[(3)]

[(1)]University of Michigan, Ann Arbor, USA
[(2)]MIT Kavli Institue for Astrophysics and Space Research, Cambridge, USA
[(3)]LAEX, Centro de Astrobiologia (CSIC-INTA), Madrid, Spain

In order to place meaningful constraints on the accretion flow in the low-hard state one requires sensitivity to both the soft X-rays (< 2 keV), in order to constrain the cool accretion disc, and higher energies in order to detect the most prominent disc reflection features (5 - 7 keV and 20 – 30 keV). Suzaku with its large bandpass and low background, is ideally equipped to carry out these observations.

SWIFT J1753.5-0127 is the candidate Galactic black hole binary (BHB) with the shortest orbital period of all of the BHBs detected to date. Here we present Suzaku X-ray observations of SWIFT J1753.5-0127 in the low-hard state. The broadband coverage of Suzaku enables us to detect the source over the energy range 0.6 - 300 keV. The broadband spectrum (2 - 300 keV) is found to be consistent with a simple power-law ($\Gamma \sim 1.65$). In agreement with previous observations of this system, an excess of soft X-ray flux consistent with the presence of a cool accretion disc is measured in addition to mild disc reflection features.

The implications of these & other observations for models of the accretion flow in the low-hard state will be discussed.

Suzaku Observations of the Galactic Centre Microquasar 1E 1740.7-2942

M. Reynolds, *J. Miller*

University of Michigan, Ann Arbor, USA

Since the discovery of the apperently super-luminal jets from the black hole binary GRS 1915+105, the Galactic microquasars have assumed a position of critical importance in our efforts to understand accretion physics and relativistic jet production.

1E1740.7-2942 is a Galactic microquasar displaying prominant double sided radio jets, which is located only 50 arc-minutes from Sagittarius A* and is the dominant source of hard X-rays (> 20 keV) in this region. In this poster, we will present the results of two Suzaku observations of this system while it resided in the low-hard state.

The 2008 outburst of SAX J1808.4-3658 observed by Swift/XRS

N R. Robba[(1)], *G. Ponetti*[(1)], *G. Cusumano*[(2)], *R. Iaria*[(1)], *T. Mineo*[(2)], *A. D'Aì*[(1)], *T. Di Salvo*[(1)]

[(1)]DSFA-Universita' di Palermo, via Archirafi 36, Palermo, Italy
[(2)]IASFPa/INAF-Palermo, via Ugo La Malfa 153, Palermo, Italy

We analised 9 Swift/XRS observations of SAX J1808.4-3658 during the 2008 outburst in the 0.2-10 keV energy band. The nine observations were taken daily from 54733 to 54741 MJD.
The data were well fitted adopting a continnum composed by a power-law component plus two blackbody components. The photon index value of the power-law component was 2.1 and did not change during the observations. The temperature value of the colder blackbody was almost constant at 0.15 keV with a peak at 0.22 keV during the observations on 54737 and 54738 MJD. The temperature values of the hotter blackbody shows a clear decreasing trend going from 1.1 keV down to 0.6 keV from 54733 to 54741 MJD, during the last two observations it was not more detected.
An alternative model is composed by a blackbody component plus a bulk motion Comptonization model (BMC in XSPEC) which mimics the colder blackbody and the power-law component of the above described model. In this case the possible scenario is that during the outburst seed photons at 0.2 keV are non-thermally Comptonized and the blackbody emission comes from the neutron star surface. We discuss these results comparing them with the previous Swift/XRS observations of SAX J1808.4-3658 during the 2005 outburst.

Swift observations of the SFXTs SAX J1818.6-1703 and IGR J11215-5952

P. Romano[(1)], *L. Sidoli*[(2)], *S. Vercellone*[(1)], *P. Esposito*[(2)], *V. La Parola*[(1)], *A. Bazzano*[(3)], *L. Ducci*[(2)], *D.N. Burrows*[(4)], *G. Cusumano*[(1)], *J.A. Kennea*[(4)], *H.A. Krimm*[(5,6)], *V. Mangano*[(1)], *N. Gehrels*[(6)]

[(1)]INAF-IASF Palermo, Via Ugo La Malfa 153, 90146 Palermo, Italy
[(2)]INAF-IASF Milano, Via Bassini 15, 20133 Milano, Italy
[(3)]INAF-IASF Roma, Via del Fosso del Cavaliere 100, 00133 Roma, Italy
[(4)]Department of Astronomy and Astrophysics, Pennsylvania State , University, University Park, PA 16802, USA
[(5)]Universities Space Research Association, Columbia, MD, USA
[(6)]NASA/Goddard Space Flight Center, Greenbelt, MD 20771, USA

We present the *Swift* observations of the supergiant fast X-ray transient (SFXT) SAX J1818.6-1703 collected during the most recent outburst, which occurred on May 6 2009. In particular, we present broad-band spectroscopic and timing analysis as well as a *Swift*/XRT light curve that spans more than two weeks of observations. We place them in the larger context of what we have learnt so far from our *Swift* campaigns on IGR J11215-5952, which is the first SFXT discovered to show periodic outbursts, probably related to the orbital period, and which is one of the best studied among SFXTs. We test our proposed model that explains the outbursts from SFXTs as being due to the passage of the neutron star inside the equatorially enhanced wind from the supergiant companion.

The Rapid Burster as seen by Swift

G. Sala[(1)], *F. Haberl*[(2)], *J. José*[(1)], *A. Parikh*[(3)], *W. Pietsch*[(2)]

[(1)]UPC-IEEC, c/ Compte d'Urgell 187, Barcelona, Spain
[(2)]MPE, PO Box 1312, Garching bei München, Germany
[(3)]TUM, Physik Department E12, Garching bei München, Germany

The Rapid Burster (MXB1730-335) is a unique object showing both type I (thermonuclear) and type II (accretion driven) bursts. The Rapid Burster experiences regular outbursts every 100-200 days, lasting for 2-4 weeks. However, in January-March 2009 the Rapid Burster experienced an unusual long plateau, with steady daily average intensities of about 50mCrab for more than 20 days. We obtained 20ks of Swift TOO observations during this period, between February 26 and March 5. All observations show intense bursting activity, with bursts intervals between 25 and 200 seconds. During the first observation, most bursts peak at fluxes higher than 10^{-8} erg/s cm^2, L = (1-1.6)x10^{38} erg/s (1-10 keV), while the peak intensity decreases in the last Swift observations. A Type I burst is observed on March 5, with indications of photospheric radius expansion.

The nova V5116 Sgr 2005: high-resolution spectra and the turn-off of the SSS

G. Sala[(1)], *M. Hernanz*[(2)], *C. Ferri*[(2)]

[(1)]UPC-IEEC, c/ Compte d'Urgell 187, Barcelona, Spain
[(2)]ICE (CSIC-IEEC), Facultat de Ciències UAB, Bellaterra, Spain

The Nova V5116 Sgr 2005 No. 2, discovered on 2005 July 4, was observed with XMM-Newton in March 2007, 20 months after the optical outburst. The X-ray spectrum showed that the nova had evolved to a pure supersoft X-ray source, indicative of residual H-burning on top of the white dwarf. The X-ray light-curve showed abrupt decreases and increases of the flux by a factor 8 with a periodicity of 2.97~h, consistent with the possible orbital period of the system. The EPIC spectra were well fit with a white dwarf atmosphere model, with the same temperature both in the low and the high flux periods, ruling out an intrinsic variation of the X-ray source as the origin of the flux changes, and suggesting a partial eclispe by the disk as the origin of the variable light curve. The RGS high resolution spectra shows a number of absorption and emission features, some of them evolving between the low and the high states. Swift monitoring showed the SSS decline in June 2008. The last XMM-Newton observation in March 2009 shows a source fainter than in the last Swift pointing, with a harder spectrum than in 2007, confirming the turn-off of the SSS. The OM also shows a decline in the optical emission, supporting the suggested picture of the irradiated secondary as the origin of the optical emission, used for determination of the orbital period.

INTEGRAL long-term monitoring results on persistently bright neutron star Low-Mass X-ray Binaries

P. Savolainen[(1)], *D. C. Hannikainen*[(1)], *A. Paizis* [(2)], *R. Farinelli* [(3)], *E. Kuulkers*[(4)], *O. Vilhu* [(5)]

[(1)]TKK / Metsähovi Radio Observatory, Metsähovintie 114, 02540, Kylmälä, Finland
[(2)]INAF - IASF, Sezione di Milano, via E. Bassini 15, 20133, Milano, Italy
[(3)]Dipartimento di Fisica, Università di Ferrara, Edificio C, Via Saragat 1, 44100, Ferrara, Italy
[(4)]ISOC, ESA/ESAC, Urb. Villafranca del Castillo, PO Box 50727, 28080, Madrid, Spain
[(5)]Observatory, University of Helsinki, PO Box 14, 00014, Helsinki, Finland

We present long-term spectral and timing results from an INTEGRAL monitoring program of persistently bright neutron star Low-Mass X-ray Binaries (LMXBs), i.e. the three bright Atoll sources GX 3+1, GX 9+1 and GX 9+9, and the Z sources GX 5-1, GX 17+2, GX 340+0 and GX 349+2. From the available observing periods between 2003 and 2009, each lasting ~2 months, we have selected a few sample periods for each source, and analyzed all JEM-X and IBIS/ISGRI data with offsets < 4 degrees. We seek an explanation for the dichotomy between the hard X-ray tails or lack thereof in the (otherwise very similar) X-ray spectra of Z sources and bright atolls, respectively.

Hard X-ray properties of magnetic cataclysmic variables

S. Scaringi[(1)], *A.J. Bird*[(1)], *A.J. Norton*[(2)], *C. Knigge*[(1)], *A.B. Hill*[(1)], *D.J. Clark*[(1)], *A.J. Dean*[(1)], *V.A. McBride*[(1)], *E.J. Barlow*[(2)], *L. Bassani*[(3)], *A. Bazzano*[(4)], *M. Fiocchi*[(4)], *R. Landi*[(3)]

[(1)]Department of Physics and Astronomy, University of Southampton, Highfield, SO17 1BJ, UK
[(2)]Department of Physics and Astronomy, The Open University, Walton Hall Milton Keynes, MK7 6AA, UK
[(3)]INAF-IASF Bologna, Via P. Gobetti 101, I-40129 Bologna, Italy
[(4)]INAF-IASF Rome, Via Fosso del Cavaliere 100, I-00133 Roma, Italy

Hard X-ray surveys have proven remarkably efficient in detecting intermediate polars and asynchronous polars, two of the rarest type of cataclysmic variable (CV). Here we present a global study of hard X-ray selected intermediate polars and asynchronous polars, focusing particularly on the link between hard X-ray properties and spin/orbital periods. To this end, we first construct a new sample of these objects by cross-correlating candidate sources detected in INTEGRAL/IBIS observations against catalogues of known CVs. We find 23 cataclysmic variable matches, and also present an additional 9 (of which 3 are definite) likely magnetic cataclysmic variables (mCVs) identified by others through optical follow-ups of IBIS detections. We also include in our analysis hard X-ray observations from Swift/BAT and SUZAKU/HXD in order to make our study more complete. We find that most hard X-ray detected mCVs have $P_{spin}/P_{orb}<0.1$ above the period gap. In this respect we also point out the very low number of detected systems in any band between $P_{spin}/P_{orb}=0.3$ and $P_{spin}/P_{orb}=1$ and the apparent peak of the P_{spin}/P_{orb} distribution at about 0.1. The observational features of the P_{spin} - P_{orb} plane are discussed in the context of mCV evolution scenarios. We also present for the first time evidence for correlations between hard X-ray spectral hardness and P_{spin}, P_{orb} and P_{spin}/P_{orb}. An attempt to explain the observed correlations is made in the context of mCV evolution and accretion footprint geometries on the white dwarf surface.

Accretion Disk Dynamics in X-Ray Binaries

N. Schulz

Massachusetts Institute of Technology (MIT), Kavli Institute for Astrophysics and Space Research, 70 Vassar Street, Cambridge, MA

The last decade of X-ray observations was an era of true discovery in the study of accretion phenomena in X-ray binaries. With the launch of high-resolution X-ray spectrometers onboard the Chandra X-ray Observatory and XMM-Newton we gained novel insights in feedback processes in accretion disks. At the forefront are dynamics in winds and outflows. Recent observations now also not only reveal properties of accretion disk coronal phenomena but point us to highly variable activity in their appearance. Amongst others these include heating along the Z-pattern in Cyg X-2, dramatic changes in the photoionzed regions in Cir X-1, and highly variable and dynamic Ne edges in the ultracompact binary 4U 0614+091. This presentation summarizes these recent developments and provides an outlook towards more dynamical accretion disk coronal models and perspectives for future missions.

Spectral and Timing Evolution of BH X-ray Binaries in Outburst. Observational Signature of Black Hole

N. Shaposhnikov[(1)], *L. Titarchuk* [(2)]

[(1)]University of Maryland/CRESST/GSFC, GSFC, ASD, B2 ROOM W20J, Greenbelt MD, 20771, USA
[(2)]Dipartimento di Fisica,Università di Ferrara, Via Saragat 1, 44100 Ferrara, Italy

We study the evolution of energy spectrum of Galactic Black Hole X-ray binaries in order to search for possible signatures of BH horizon. We find that the saturation of the photon index of the non-thermal spectral component is observed during BH state transitions from low-hard to highsoft states in agreement with the Bulk Motion Comptonization model. We present observational and theoretical arguments that the index saturation effect is a black hole horizon signature.

Multiwavelength observations of the long-term variability in LMXB 4U 1636-536

I C. Shih [1,2], *A. Bird* [3], *P.A. Charles* [3,4], *R. Cornelisse* [5]

[1]Institute of Astronomy, National Tsing-Hua University, Hsin-Chu, Taiwan
[2]Department of Physics & Astronomy, Michigan State University, East Lansing, U.S.A.
[3]School of Physics & Astronomy, University of Southampton, Southampton, U.K.
[4]South African Astronomical Observatory, Cape Town, South Africa
[5]Instituto de Astrofisica de Canarias, La Laguna, Spain

We present the result of multiwavelength observations of LMXB using archive RXTE/ASM, SWIFT/XRT and optical data with the SMARTS 1.3 m telescope. 4U 1636-536 was considered a persist, bright X-ray burster until 2002 when RXTE/ASM observed an apparent decline in its X-ray flux. At the same period, it started to exhibit a large amplitude, quasi-periodic variability to the present day. The most significant feature of this variability is that the high X-ray flux (20-100 keV, INTEGRAL/IBIS) is apparently anti-correlated with the soft X-ray flux (2-12 keV, RXTE/ASM). Shih et al. (2004) interpreted such feature as the result of an accretion disk instability due to the decrease of mass accretion rate from the secondary star. We examined the archive data of RXTE/ ASM and SWIFT/XRT in the past five years and confirmed that the anti-correlation is not just an isolated event but a general phenomenon. Furthermore such variability is unstable in the long term and a coherence changing can be seem among the observed wavelengths: hard, soft X-rays and optical. Our three months optical monitoring in 2008 shows that the optical fluctuation is correlated with the soft X-rays, thus it is consist with the general accepted theory that the optical counterpart is mostly generated by X-ray reprocessing.

The quasi-periodic variability and anti-correlation phenomena can be described by accretion instability due to a decreasing accretion rate, but others have proposed different mechanism, such as disk-jet coupling. We suggest that, in the future, X-ray timing-dependence spectroscopy observations may provide more information about this fascinating binary system.

Echo outbursts in X-ray binaries – the case of KS 1731-260

V. Simon

Astronomical Institute AS CR . 25165 Ondrejov, Czech Republic

The thermal instability of accretion disk is thought to play an important role in the activity of low-mass X-ray binaries (LMXBs). It should also appear when a (quasi)persistent LMXB like KS 1731-260 goes into its low state. In our interpretation, the irradiation of the donor during the main outburst lead to an increase of the mass transfer rate dm/dt, which prolonged this event. Only a slow decrease of this dm/dt after the end of the main outburst lead to the formation of the central disk region kept in the ionized state by irradiation, surrounded by the outer thermally unstable disk region. This gave rise to the series of the outside-in echo outbursts caused by the still continuing dm/dt via the mass stream impinging the outer disk rim. We argue that introducing any bursts of matter from the donor as the cause of the echo outbursts is superfluous. We find important common features in the evolution of the echo outbursts in various systems including KS 1731-260. We find an increase of the mean recurrence time of the echo outbursts, T_{C}, with the orbital period P_{orb} in the ensemble consisting of both soft X-ray transients and dwarf novae, and attribute it to the increase of the size of the accretor's lobe with P_{orb}.

Cycles in the outbursts – the case of GRS 1747-312

V. Simon

Astronomical Institute AS CR , 25165 Ondrejov - Czech Republic

We investigate the mechanisms responsible for the variations of the outburst recurrence time T_C. We reveal a cyclic behavior in the residuals of this quantity in soft X-ray transient GRS 1747-312, the mean value of T_C being 136 days. The profile of this cycle is approximately sinusoidal. We find that the most luminous outbursts occur after the longest T_C, while the variations of fluence are not related to the cycle – fluence displays a large scatter for the individual outbursts and tends to decrease with time. We argue that although the cycle-length of 5.4 years is compatible with that of the presumed magnetic activity of the late-type donor, it cannot be explained by variations of the mass outflow from the donor to the disk. In our interpretation, the stellar activity is translated to variations of T_C via interaction of the magnetic field of the spots on the donor with the magnetic field of the disk. This gives rise to a variable efficiency of the removal of the angular momentum from the quiescent disk during the activity cycle of the donor.

Cycles and their instability in the intermediate polar V795 Her

V. Simon, C. Polasek, R. Hudec, M. Blazek

Astronomical Institute AS CR , 25165 Ondrejov - Czech Republic

We analyze the cycles in the intermediate polar V795 Her, the optical counterpart of 2RXP ***J171256.0+333121***. We make use of the dense series of the photometric CCD observations, mostly in the *B* filter, obtained within the interval of 5 days in 2009. We find that the times of the minimum intensity of the known cycle of about 2.8028 days are more stable than those of the peak intensity. The profile of this modulation displays considerable variations on the timescale of days, with the largest changes observed near the moment of the peak intensity. In addition, our wavelet analysis shows that another superimposed cycle of about 0.01 days may be stable in some nights, but it may undergo abrupt changes within a single night. We discuss our observations in term of superhumps in the disk embedding the magnetized white dwarf.

The Anomalous Low State of LMC X-3

A. P. Smale, P. T. Boyd, C. B. Markwardt

NASA/Goddard Space Flight Center, Code 660, Greenbelt Road, MD 20771, USA

RXTE ASM observations of the black hole binary LMC X-3 reveal a dramatic and extended very low X-ray state lasting from December 8, 2003 until March 18, 2004; archival RXTE PCA data sample the event well, with 28 well-spaced observations over 64 days, totalling 150 ksec of good observing time. These data show that this event is unprecedented both in terms of its low luminosity ($L_{x(2-10keV)}$=4.2x10^{35} erg s^{-1}, ~4 times fainter than ever before seen from LMC X-3 in its low/hard state, and representing 0.15% of its X-ray luminosity during the high/soft state), and long duration (~100 days, *cf* 10-20 days for ‘normal’ low/hard state excursions). During this extended low state little to no source variability is observed, and the X-ray spectrum from 3-25 keV is well described by a simple power law with index 1.7±0.2. Following the event, the long-term variability characteristics of LMC X-3 (2004 Apr-2009 May), as derived using RXTE ASM data, are measurably distinct from its characteristics prior to the event (1996 Jan-2003 Dec). We compare this extended low state with other low/hard episodes in LMC X-3 and low states in other black hole binaries and show that, while it differs from these in many respects, it shares many similarities with the anomalous low states observed in the precessing-disk neutron star binary Her X-1.

Accretion states in ultraluminous X-ray sources

R. Soria

MSSL, University College London, Holmbury St Mary, RH5 6NT, United Kingdom

The "canonical" classification of stellar-mass black hole accretion states comprises a "low/hard" state (radiatively inefficient, dominated by inverse-Compton emission and steady jet), a "high/soft" state (dominated by a radiatively efficient standard disk) and on rare occasions, a "very high state" (with both a steep power law and a disk component). This simple scheme was also applied to AGN. X-ray studies of ultraluminous X-ray sources (ULXs) over the past decade have revealed a more complex state structure. Some ULXs may be in the very high state or "slim disk" state. Others (especially the most luminous sources, at L > 1E40 erg/s) have a hard power-law spectrum, a "high/hard" state unknown in Galactic black holes. And most ULXs never seem to switch to the disk-dominated high/soft state even when they decline in luminosity. I will discuss possible interpretations of these findings in terms of black hole masses and accretion rates.

Yet another periodicity in the accreting binary X-ray pulsar Her X-1

R. Staubert[(1)], *D. Klochkov*[(1)], *A. Santangelo*[(1)], *N. Shakura*[(2)], *K. Postnov*[(2)], *J. Wilms*[(3)]

[(1)]Institute für Astronomie und Astrophysik, Tübingen, Germany
[(2)]Sternberg Astronomical Institute, Moscow, Russia
[(3)]Dr. Karl Remeis-Sternwarte, Bamberg, Germany

We report about the discovery of quasi-periodic variations in the X-ray flux of Her X-1 on a time scale of 150 to 200 days. The modulation in flux appears to be correlated with variations in the pulse period near 1.237 sec. We will discuss the correlated long-term modulations of flux, pulse period and precession period (of both the accretion disk and the neutron star) in the light of a physical model assuming strong feed-back between the principle components of the binary system.

Study of the Spectral and Temporal Characteristics of X-Ray Emission of the Gamma-Ray Binary LS5039 with *Suzaku*

T. Takahashi[1,2]*, T. Kishishita*[1,2]*, Y. Uchiyama*[3]*, T. Tanaka*[3]*, K. Yamaoka*[4]*, D. Khangulyan*[5]*, F. A, Aharonian*[5,6]*, V. Bosch-Ramon*[5]*, J. A. Hinton*[7]

[1]Institute of Space and Astronautical Science/JAXA, 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan
[2]Department of Physics, University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo, 113-0033, Japan
[3]Kavli Institute for Particle Astrophysics and Cosmology, SLAC National Accelerator Laboratory, 2575 Sand Hill Road M/S 29, Menlo Park, CA 94025
[4]Graduate School of Science and Engineering, Aoyama Gakuin University, 5-10-1 Fuchinobe, Sagamihara, Kanagawa 229-8558, Japan
[5]Max-Planck-Institut fuer Kernphysik, Saupfercheckweg 1, Heidelberg 69117, Germany
[6]Dublin Institute for Advanced Studies, 31 Fitzwilliam Place, Dublin 2, Ireland
[7]School of Physics & Astronomy, University of Leeds, LS2 9JT, Leeds, UK

We report on the results from *Suzaku* broadband X-ray observations of the galactic binary source LS5039. The *Suzaku* data, which have continuous coverage of more than one orbital period, show strong modulation of the X-ray emission at the orbital period of this TeV gamma-ray emitting system. The X-ray emission shows a minimum at orbital phase ~0.1, close to the so-called superior conjunction of the compact object, and a maximum at phase ~ 0.7, very close to the inferior conjunction of the compact object. The X-ray spectral data up to 70~keV are described by a hard power-law with a phase-dependent photon index which varies within Gamma ~1.45 - 1.61.The *Suzaku* result implies a phenomenon different from the ``standard" origin of X-rays related to the emission of the hot accretion plasma formed around the compact companion object. The X-ray radiation of LS5039 is likely to be linked to very-high-energy electrons which are also responsible for the TeV gamma-ray emission. While the gamma-rays are the result of inverse Compton scattering by electrons on optical stellar photons, X-rays are produced via synchrotron radiation. The observed modulation of synchrotron X-rays requires an additional process, the most natural one being adiabatic expansion in the radiation production region.

Spectral evolution of the Atoll source 4U 1728-34 with RXTE and INTEGRAL: evidence for hard X-ray tail

A. Tarana[1], A. Bazzano[1], T. Belloni[2], J. Homan[3], M. Méndez[4] and P. Ubertini[1]

[1]IASF-Roma/INAF, Italy
[2]OAB-Merate/INAF, Italy
[3]MIT, Cambridge, USA
[4]Kapteyn Astronomical Institute, University of Groningen, The Netherlands

We report results on the Neutron Star Low Mass X-ray Binary 4U 1728-34 during a monitoring campaign with RXTE and INTEGRAL starting on 2006 March up to 2007 June. The relative light curves showed three outbursts with different peak luminosity. During these outbusrsts the source moves from the Soft spectral state (banana) to Hard spectral state (island) as evidenced by the Hardness-Intensity diagram. We perfomed a contemporaneous broad spectral analysis with both satellites (with PCA, HEXTE and IBIS instruments) and compared the different spectral states. In particular the hard spectral states are characterized by a Comptonization model plus a hard X-ray tail extending up to 200 keV, which could be due to a non-thermal emission (maybe connected to radio emission) coming from the source at the lower accretion rate of the island state. While for the Black Hole Candidates the hard X-ray tails are often detected during hard states, this was not the case for Atolls. However in recent years there are evidence of detections of this feature from Atolls showing that the so called disk-jet coupling could be also present for the NS systems. The past radio detection of 4U 1728-34 strengthen this suggestion.

Systematic surveys of the non thermal emission from white dwarfs with Suzaku and INTEGRAL

Y. Terada[(1)], *M. Ishida*[(2)], *K. Makishima*[(3)(4)], *K. Mukai*[(5)], *T. Dotani*[(2)], *A. Bamba*[(2)], *T. Hayashi*[(2)(6)], *A. Harayama*[(1)], *K. Morigami*[(1)], *S. Okada*[(2)], *R. Nakamura*[(2)], *S. Naik*[(7)]

[(1)]Saitama University, 255 Sakura-ku Saitama-city Saitama, Japan
[(2)]ISAS/JAXA, 3-1-1 Yoshinodai Sagamihara Kanagawa, Japan
[(3)]RIKEN, 2-1 Hirosawa Wako Saitama, Japan
[(4)]University of Tokyo, 7-3-1 Hongo Bunkyo-ku Tokyo, Japan
[(5)]NASA/GSFC, Creenbelt MD 20771, USA
[(6)]Tokyo Metroporitan University, 1-1 Minami-Osawa Hachioji, Tokyo
[(7)]Physical Research lab, Ahmedabad 380 009, India

The origin of cosmic-rays (CRs) stays a long-standing mystery for near 100 years. The Suzaku discovery of a white dwarf pulsar (Terada et. al. 2008) demonstrated us a possibility that a magnetized white dwarf (WD) is a particle accelerator. If WDs are actually CR origin, they play very important rule on soft CRs because of their numerous existences. In addition, if X-rays from WDs actually have thermal + non-thermal properties like the WD pulsar, they can be tested to another important mystery of the X-ray astronomy, whether the Galactic Ridge emission comes from diffuse plasmas or point sources like cataclysmic variables (CVs). Thus, continuous searches for other possible WD pulsars with Suzaku and INTEGRAL have been performed. After picking up WDs with known magnetic field strengths and spin periods from catalogs of CVs and isolated WDs, objects whose induced electric potentials exceed 10^{12} volts and dipole radiations over 10^{29} erg / s are selected like AM Her, EUVE J0317-85, PG1031+234, LHS1734, PG1015+014 etc. Their X-rays were studied with INTEGRAL archive data and/or Suzaku follow-up observations, and finally a promising non-thermal emission from an object, AM Her in a very low state, has been found with Suzaku. In the presentation, contributions of normal WDs to CRs will be discussed. The comparison between X-rays from WD pulsars and the Galactic ridge emission is also discussed.

Accretion disc variability: intrinsic variations and X-ray reverberation in X-ray binaries

P. Uttley, T. Wilkinson

University of Southampton, Southanmpton SO17 1BJ, United Kingdom

X-ray emission and reflection from accretion discs provides the key evidence for the behaviour of matter and the effect of strong gravity close to black holes and neutron stars. However, comparatively little is known about how accretion disc emission in X-ray binaries varies on short time-scales (seconds or less). These variations can be due both to intrinsic fluctuations in disc temperature and structure and the effects of X-ray reverberation (reprocessing and reflection of the variable power-law continuum by the disc). I will review recent results in the field of short-time-scale disc variability, focusing on disc signatures in rms-spectra and interband time-delays. In particular, I will present the first evidence that in the hard states of black hole X-ray binaries, intrinsic disc fluctuations are responsible for the ubiquitous low-frequency Lorentzian component seen in the PSD. I will also show the effects of the disc on time delays between X-ray bands, and discuss the exciting prospects for X-ray reverberation-mapping of discs with the International X-ray Observatory. Throughout my discussion, I will link the XRB behaviour with comparable behaviour which is being uncovered in AGN.

NORMAL AND STURBURST GALAXIES

Orals

The X-ray Properties of Luminous Infrared Galaxies:
Fueling Starbursts and Building Massive Black Holes

D.B. Sanders

Institute for Astronomy, University of Hawaii (USA)

During its first decade, Chandra has managed to obtain ACIS-S observations of a complete sample of 44 luminous and ultra-luminous infrared galaxies with infrared luminosities, log (Lir/Lsun) > 11.7. These (U)LIRGs represent the most luminous infrared galaxies in the all-sky IRAS Revised Bright Galaxy Survey.

Previous multi-wavelength studies have convincingly shown that all of these sources can be described as major mergers (~L*-L*) of molecular gas-rich spirals.

I will summarize the properties of these rather exotic objects, including their X-ray spectral shapes, sizes, hardness ratio, and Lir/Lx. Despite evidence at other wavelengths for the presence of powerful starburst activity and binary AGN, these (U)LIRGs as a class are, somewhat surprisingly, "under-luminous" in Lx(2-10keV) by an average of ~0.7dex, compared to lower luminosity starbursts and normal star-forming galaxies, Enormous nuclear concentrations of dense molecular gas clearly shape the observed X-ray spectra of these objects, consistent with our detection of several Compton-thick AGN as well as our stacking analysis of the majority of "hard X-ray quiet" (HXQ) objects. A plausible evolutionary scenario for (U)LIRGs, including the expected merger frequency of binary AGN, will be presented.

X-ray properties of normal galaxies

G. Trinchieri

Osservatorio Astronomico di Brera

After the first observations with the Einstein Observatory, the X-ray properties of normal galaxies have hugely benefited from deeper and more detailed observations that have greatly improved our understanding and helped us focus on the relevant issues.
I will briefly review our current knowledge of the X-ray properties of galaxies and their environment in the local Universe, and illustrate related outstanding issues.

Studying the Evolution of Normal Galaxy Populations in X-rays: Results from the Deepest *Chandra* Surveys

B. D. Lehmer and collaborators

Durham University, Department of Physics, South Road, Durham, DH1 3LE, UK

Ultra-deep extragalactic X-ray surveys with *Chandra* have only recently enabled studies of cosmologically distant (z > 0.1) populations of normal galaxies that are not dominated by luminous AGNs. The X-ray emission from these galaxies originates from X-ray binaries, supernovae and their remnants, hot interstellar gas, and young stars, which therefore provides a sensitive and relatively unobscured view of activity associated with recent and past star-formation activity. In the deepest *Chandra* surveys to date (the *Chandra* Deep Fields) it is now possible to perform reliable studies of galaxy populations through X-ray stacking without significant AGN contamination. I will highlight and discuss recent investigations of the X-ray properties and evolution of normal galaxy populations over the redshift range z = 0-4 (the last ~90% of cosmic history). I will also outline how planned future X-ray studies and missions will provide a way forward for improving understanding of galaxy evolution.

X-ray gaseous emission in star forming galaxies

P. Ranalli[(1)], *A. Comastri*[(2)], *R. Maiolino*[(2)], *L. Origlia*[(2)], *G. Setti*[(1)]

[(1)]Università di Bologna, ITALY
[(2)]INAF, ITALY

The understanding of the physical state of the X-ray emitting hot gas in star forming galaxies has been greatly improved thanks to spatially-resolved and high resolution X-ray spectroscopy. Observations of the prototype starburst galaxy M82 with XMM-Newton and Suzaku have shown spatially dependent chemical abundances, non-thermal effects in X-ray plasma emission, and the first discovery of charge-exchange emission in X-rays from an external galaxy. In this talk I will present these recent findings, and extend this work to other template objects such as NGC253 and NGC3256.

The Gas Dynamics of NGC 4472

R. P. Kraft[1], *W. R. Forman*[1], *C. Jones*[1], *P. E. J. Nulsen*[1] *M. J. Hardcastle*[2], *D. A. Evans*[3], *S. Raychaudhury* [4], *G. R. Sivakoff*[5], *C. Sarazin*[5], *S. S. Murray*[1]

[1]Harvard/Smithsonian Center for Astrophysics, 60 Garden St., MS-4, Cambridge, MA, USA
[2]University of Hertfordshire, School of Physics, Astronomy, and Mathematics, Hatfield AL10 9AB, UK
[3]MIT Kavli Institute Institute for Astrophysics and Space Research, 77 Massachusetts Ave., NE 80, Cambridge, MA 02138, USA
[4]University of Birmingham, School of Physics and Astronomy, Edgbaston, Birmingham B15 2TT, UK
[5]University of Virginia, Department of Astronomy, Charlottesville, VA, 22904, USA

We present preliminary results from a 100 ks XMM-Newton observation of the hot gas in the nearby massive early-type galaxy NGC 4472. This galaxy is the central member of a group of galaxies that is believed to be falling into the Virgo cluster. We find several structures in the gas indicative of a previous epoch of nuclear activity and of a complex interaction with the ICM of the Virgo cluster. First, we detect two pairs of cool filaments that extend 25 kpc to the east and southwest of the nucleus. One of these filaments was detected in an earlier Chandra observation and is known to have a sharp, well-defined interface with the ambient medium. These filaments are likely the remnants of cooler gas that has been entrained by buoyant radio bubbles from a previous epoch of nuclear activity. Second, we detect complex temperature structures in the central few kpc of the gas. We find a region of cooler gas to the southeast of the nucleus, in the opposite direction to the infall of NGC 4472 into the Virgo cluster. This cannot be the direct result of ram pressure stripping by the Virgo cluster gas as the gas density of NGC 4472 is far too large. More likely it is the result of subsonic gas motions in the core induced by the merger. This result is supported by the detection of multiple surface brightness discontinuities in the gas in the Chandra observation. Finally, we present radial abundance profiles for the elements of O, Si, S, and Fe and discuss their implications.

Bipolar X-ray Lobes Around the Galactic Center

M. R. Morris[1], *M. P. Muno*[2] , *F. K. Baganoff*[3]

[1]Dept. of Physics & Astronomy, Univ. of California, Los Angeles, CA 90095-1547, USA
[2]Lincoln Labs, Boston, MA USA
[3]Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology, Cambridge, MA 02139, USA

Imaging of the Galactic center with both Chandra and XMM has revealed the presence of bipolar X-ray lobes oriented perpendicular to the Galactic plane, and centered on the central black hole, Sagittarius A*. The lobes appear to be ~10-pc bubbles of hot gas at a temperature of a few times 10^7 K. At a few locations on the periphery of the lobes, we find excess emission with a relatively hard, probably nonthermal spectrum. Sgr A* is an obvious candidate for the origin of the bipolar lobes, although at present, there is no compelling observational evidence for a large-scale wind or jet from that source. However, other potential sources warrant consideration and will be discussed. It is not clear whether the wind is intrinsically collimated at the source, or whether the bipolar flow has been shaped by interaction with the Galactic layer of interstellar matter. Finally, we consider on the basis of the internal morphology of the X-ray source whether the wind production is episodic, with repetition time scales on the order of 10^3 years.

Surveying the Galactic Plane with XMM-Newton

R. Warwick[(1)], *D. Perez-Ramirez*[(2)]

[(1)]Department of Physics and Astronomy, University of Leicester, Leicester LE1 7RH, U.K.
[(2)]Departmento de Fisica, Universidad de Jaen, Campus Las Lagunillas, E-2307 Jaen, Spain

We report on an investigation of the serendipitous X-ray source populations discovered in XMM-Newton observations in the Galactic Plane within the central quadrant of the Galaxy. The survey focuses on over 2200 2XMM sources at intermediate to faint fluxes drawn from a total 98 XMM-Newton fields.

There is a roughly equal numerical split between the spectrally soft and spectrally hard samples. A high fraction (>60%) of the spectrally soft sources have near-infrared 2MASS/UKIDSS objects inside their error circles consistent with the dominant population being coronally emitting stars. The exact makeup of the hard source population is less obvious, although the distribution of hardness ratio and the variation in the surface density as a function of X-ray flux and Galactic latitude/longitude allow some details of the underlying luminosity and spatial distribution of the parent populations to be inferred. An interesting discovery is an excess in the surface density of soft sources between galactic longitude 7-15 deg; we speculate on the possible origin of this feature

NORMAL AND STURBURST GALAXIES

Posters

Galactic wind in the bulge of Andromeda Galaxy

A. Bogdan[(1)], *M. Gilfanov*[(1,2)]

[(1)] Max Planck Institut für Astrophysik, Karl-Schwarzschild-Str.1, 85741 Garching bei München, Germany
[(2)] Space Research Institute, Russian Academy of Sciences, Profsoyuznaya 84/32, 117997 Moscow, Russia

We investigate the unresolved X-ray emission originating from the bulge of M31. We show that a part of this emission is due to a large number of faint sources - mainly accreting white dwarfs and active binaries, associated with the old stellar population, similar to the Galactic ridge X-ray emission of the Milky Way.

We also detect soft X-ray emission from ionized gas. It has a temperature of 3-4 million K and its mass is about few million solar masses. The gas distribution is extended along the minor axis of the galaxy suggesting that it may be outflowing in the direction perpendicular to the disk of M31 at the rate of ~0.1 solar masses per year. The mass and energy budget of this galactic wind is maintained by the mass loss from evolved stars and by the energy input from type Ia Supernovae.

Evolution of tidal disruption events discovered with XMM-Newton

P. Esquej[1], *S. Komossa*[2], *A.M. Read*[1], *R.D. Saxton*[3]

[1]Dept. of Physics and Astronomy, Leicester University, Leicester LE1 7RH, UK
[2]Max-Planck-Institut für extraterrestrische Physik, Giessenbachstrasse 1, 85748 Garching, Germany
[3]ESA/ESAC, Apartado 78, 28691 Villanueva de la Cañada, Madrid, España

The paradigm that the cores of most, if not all, galaxies are occupied by supermassive black holes (SMBHs) was predicted long ago by theory. While it has been demonstrated that active nuclei powered by gas accretion onto SMBHs populate the cores of a number of galaxies, confirmation of their dormant state lurking in non-active galaxies is difficult to obtain. An unavoidable consequence of the existence of remnant SMBHs is the detection of flare radiation produced when a star is tidally disrupted and accreted by SMBHs. These occurrences, so-called tidal disruption events, would generate outbursts of EUV/X-ray radiation decaying on a time scale of several months to years. Although active galactic nuclei can also be susceptible to these phenomena, the most unambiguous cases for a stellar disruption come from host galaxies with no – or only faint – permanent activity. Two sources have been detected with XMM-Newton during slew observations presenting properties in full agreement with the tidal disruption model. As only a few number of objects of this type have been discovered to date, the discovery of more cases allow a number of fundamental conclusions to be drawn such as their frequency and the distribution of quiescent black hole masses among others. Here we present results from optical and X-ray follow-up observations of such objects, and the discussion within the environment presented above.

The XMM-Newton survey of the Small Magellanic Cloud – First results

F. Haberl and the XMM-Newton large project collaboration

Max-Planck-Institut für extraterrestrische Physik, Giessenbachstrasse, 85748 Garching, Germany

The local group galaxies are best suited to study their X-ray source populations using present day observatories. Extending the existing archival observations, we are conducting a large program with XMM-Newton to obtain a complete X-ray survey of the Small Magellanic Cloud (SMC) in the 0.1-10 keV band. Utilizing the high sensitivity of XMM-Newton we can reach a limiting point source luminosity of $\sim 2 \times 10^{33}$ erg/s and perform a detailed spectral and temporal analysis of sources with X-ray luminosities down to $\sim 10^{35}$ erg/s with exposures of 30 ks. The proximity of the SMC makes it the ultimate target for obtaining a complete inventory of supersoft X-ray sources, high mass X-ray binaries and supernova remnants and to study the diffuse emission of the hot interstellar medium. The analysis of the archival data already revealed a new SNR and a number of new Be/X-ray binary pulsars, further increasing the large sample of high mass X-ray binaries in the SMC. I'll present first results from our ongoing SMC survey.

X-ray monitoring of Classical Novae in M 31 from June 2006 to March 2007

M. Henze , *W. Pietsch, and F. Haberl for the M 31 nova monitoring collaboration*

Max-Planck-Institut fuer extraterrestrische Physik, D-85748 Garching, Germany

We report the first results of a monitoring program for supersoft X-ray source (SSS) states of classical novae (CNe) in the centre region of our neighbour galaxy M 31, carried out between June 2006 and March 2007 with XMM-Newton EPIC and Chandra HRC-I. This work is a follow up of the studies of Pietsch et al. (2005, A&A, 442, 879; 2007, A&A, 465, 375) who used archival ROSAT, XMM-Newton and Chandra data to find that CNe represent the major class of SSSs in M 31. We detected six CN counterparts and systematically determined their X-ray light curves, as well as hardness ratios and spectra, if possible. Additionally, we computed upper limits for the X-ray luminosity of all the CNe which were active as SSSs before and are no longer detected or which had their optical outburst in the range from a year before our first observation until the end of the X-ray coverage. Three previously known SSS counterparts were still active 9.7, 5.6 and 2.8 years after their optical outburst, respectively. From the three new CNe two objects show only a very short SSS state. One of these sources shows noticeable luminosity variations within an observation, which may point to a periodicity in the X-ray flux. Novae with short (< 100 d) SSS phases are believed to contain massive white dwarfs and are therefore discussed as progenitor systems for supernovae type Ia.

Multiwavelength follow-up of Chandra X-ray discovered sources in the Galactic Bulge

P.G. Jonker[1,2] *, C. Bassa*[1] *, G. Nelemans*[3] *et al.*

[1]SRON, Netherlands Institute for Space Research, Sorbonnelaan 2, 3584CA, Utrecht, NL
[2]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, MA 138, USA
[3]Nijmegen Univercity, Tournooiveld 2, Nijmegen, NL

We discovered ~1700 X-ray sources in Chandra observations of an area of 8.4 square degrees centered on the Galactic Center: the Galactic Bulge Survey. For ~1200 sources we discovered counterparts on our existing optical Blanco images of the field. The plethora of faint X-ray sources will constrain binary evolution models by way of a number count and by identifying predicted X-ray binary types that so far have eluded identification. For this we have started using optical spectroscopy to identify the X-ray sources. We expect to find (quiescent and/or eclipsing) neutron star and black hole LMXBs. These are important for neutron star and black hole mass measurements. We will present the first results of our multiwavelength follow-up of these Chandra X-ray discovered sources.

High-resolution X-ray spectroscopy of the interstellar medium

J.S. Kaastra, A.J.J. Raassen, C.P. de Vries, E. Costantini, C. Pinto

SRON, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands

Due to the high spectral resolution of present-day grating spectrometers, it is now possible to study interstellar X-ray absorption in detail. These absorption measurements allow for the determination of the composition of the material along the line of sight, in terms of dust to gas ratio, and for the gas the ratio of hot to cold gas can be measured. Also the chemical composition of the gas can be determined, in particular for elements like Mg, Ne, Fe, O and N. We give here a few recent examples of accurate abundance measurements from our group. In two sources we are able for the first time to constrain the N/O ratio reliably. Furthermore, we have improved and calibrated models for the fine structure near the atomic oxygen and nitrogen edges. For nitrogen we find an edge position that is significantly off from older databases. For the atomic oxygen edge we have resolved the confusion about the precise wavelengths of the main features.

Broad view on hard X-ray background emission of the Galaxy

R. Krivonos, [1,2], *M. Revnivtsev*[3,2] , *S. Tsygankov*[1,2], *E. Churazov*[1,2] , *R. Sunyaev*[1,2]

[1]Max Planck Institute for Astrophysics, Garching, Germany
[2]Space Research Institute, Moscow, Russia
[3]Excellence Cluster Universe, Technische Universitat Muenchen, Garching, Germany

The origin of Galactic ridge X-ray emission (GRXE) was remaining a puzzle for the years after its discovery in early 80th of the last century. Only complex view on Galaxy background with surveys at different frequencies made it possible to achieve great progress in GRXE understanding. Using near-infrared Galaxy maps measured with DIRBE experiment and data from hard X-ray surveys of RXTE and INTEGRAL observatories, we show that galactic background is originated from stellar population of the Galaxy which is in contrast to diffuse nature believed before. We will discuss the properties of GRXE in wide context of the Galaxy emission, considering morphology, spectrum and stellar population, and show recent results obtained from dedicated GRXE observations with INTEGRAL and Chandra.

Demographics of black holes in nearby galaxies

S. Mathur, H. Ghosh, F. Fior, L. Ferrarese

The Ohio State University 140 West 18th Ave Columbus, OH 43220, USA

The cumulative mass function needed to explain the energetics of high redshift quasars implies that all galaxies in the local universe should host supermassive black holes (SBHs). The mass function of redshift zero SBHs, however, is unknown, especially at the low-mass end. Low-mass SBHs are impossible to detect dynamically because their sphere of influence cannot be resolved with current telescopes. AGN activity is the best way, and perhaps the only way, of finding low mass SBHs. Given the M_BH - M_Bulge relationship, we expect the low-mass SBHs to be in late-type spirals. We present results from a Chandra survey for finding low mass supermassive black holes in nearby galaxies. We use multiwavelength data to weigh the arguments for and against each object being in fact an accreting SBH; XMM-Newton spectroscopy has been important in this respect. We show how X-ray observations are effective in uncovering hidden SBHs in what were thought to be ``normal" galaxies in the local Universe.

The multicolor field of the dwarf spheroidal galaxy Leo I

M. Orio[1,2], *L. Pavan*[2], *J. Gallagher*[2], *E. Held*[2], *U. Munari*[2], *L. Zampieri*[2]

[1]INAF - Padova Astronomical Observatory, Padova, Italy
[2]Department of Astronomy, University of Wisconsin, Madison, WI, USA

We present a deep XMM-Newton observation of the dwarf spheroidal galaxy Leo I, a field never observed before in X-rays. We cross-correlated more than a hundred X-ray sources observed in his field with deep optical and near-IR counterparts observed with HST-ACS and with optical telescopes, and searched radio and optical archives. We identified several AGN and candidate AGN counterparts and a number of likely X-ray binaries in this galaxy. We discuss the implications of our results for the evolution and star formation of the Leo I galaxy and its dark matter content. We also compare the results with recent observations of other dwarf galaxies in the Local Group and discuss some peculiar sources more in detail.

Probing the LMXB-GC connection in NGC1399

M.Paolillo[(1)], *T. Puzia*[(2)], *S.E. Zepf*[(3)], *T.J. Maccarone*[(4)], *P.Goudfrooij*[(5)], *A.Kundu*[(6)], *G.Fabbiano*[(7)], *L.Angelini*[(8)]

[(1)] Universita di Napoli "Federico II", Italia
[(2)] Herzberg Institute of Astrophysics, Victoria, Canada
[(3)] Department of Physics and Astronomy, Michigan State University, USA
[(4)] School of Physics and Astronomy, University of Southhampton, Southhampton, UK
[(5)] Space Telescope Science Institute, Baltimore, USA
[(6)] Department of Physics and Astronomy, Michigan State University, USA
[(7)] Harvard-Smithsonian Center for Astrophysics, Cambridge, USA
[(8)] Laboratory for X-Ray Astrophysics, NASA, Goddard Space Flight Center, Greenbelt, USA

We present the result of a wide-field study of the Globular Cluster/Low Mass X-ray Binaries connection in the giant elliptical NGC1399. Combining Chandra ACIS and HST/ACS observations we are able to probe the GC and LMXB population out to ~6 effective radii. We find evidence that LMXB formation likelyhood is influenced by GC structural parameters, in addition to the well known effects of mass and metallicity, independently from galactocentric distance.

Optical novae as supersoft X-ray sources in M 31

W. Pietsch

Max-Planck-Institut für extraterrestrische Physik, Giessenbachstraße, 85741 Garching, Germany

Only for few Galactic classical novae (CNe) the duration of the supersoft X-ray source (SSS) state has been determined due to X-ray observation constraints and the small number of CN detected (8/y). In contrast, more than 20 CNe are detected in M 31 per year, 85% of them in the central region. Several CN can be monitored in one X-ray field. The first M 31 SSS/CN identification was based on ROSAT observations. Searching archival ROSAT, XMM-Newton and Chandra M 31 observations obtained before July 2002, we detected 20 additional X-ray counterparts for CN candidates (mostly identified as SSS by their hardness ratios). This proved that CNe constitute the major class of SSS in M 31. Analyzing archival Chandra observations of M 31 obtained from July 2004 to February 2005 we could demonstrate that nova SSS states lasted from months to about 10 y. Several novae showed short X-ray outbursts starting within 50 d after the optical outburst and lasting only two to three months. The number of optical novae detected in soft X-rays was more than 30%. The XMM-Newton large program which mapped the entire M 31 disk, and specific continuing XMM-Newton/Chandra monitoring programs of the central area of M 31 increased the CN/SSS census to more than 50. Some of the novae showed very short SSS phases. Together with optical information the SSS light curves can be used to estimate the mass of the WD, of the ejecta and the burned mass in the outburst.

High resolution X-RAY spectroscopy of the multiphase interstellar medium

C. Pinto [(1)], *J. S. Kaastra* [(1,2)], *E. Costantini* [(1)] *and F. Verbunt* [2]

[(1)]SRON Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA Utrecht, the Netherlands
[(2)]Astronomical Institute, Utrecht University, P.O. Box 80000, 3508 TA Utrecht, The Netherlands

In the last decades high resolution X-ray spectroscopy has become a powerful diagnostic tool for constraining the chemical and physical properties of the interstellar medium. Through the study of the X-ray absorption lines in the spectra of the background sources it is possible to probe the various phases of the interstellar medium of the Galaxy, among them the most relevant are the cold neutral gas and the warm-hot ionized gas. Some results on the element abundances suggest that even the dust grains could play an important role in the absorption features. Here we present a high quality RGS spectrum of the low mass X-ray binary GS 1826-238 with a detailed treatment of the absorption features due to both the neutral and the ionized gas of the ISM. We found significant deviations from the solar abundances in some elements: neon appears to be over-abundant while iron is under-abundant. These effects could be due to evolution effects and iron depletion in dust grains.

X-rays from Normal Galaxies: Near and Far

A. Ptak

Johns Hopkins University, Baltimore Maryland, USA

We will discuss an analysis of the normal galaxy content of the Chandra and XMM-Newton archives with emphasis on their integrated X-ray emission. We are correlating the X-ray luminosities with (other) star-formation rate (SFR) and stellar mass estimates, and preliminary results suggest a break on the X-ray/SFR correlation. We will discuss the application of these results to the evolution of the X-ray emission of normal galaxies in the Chandra Deep Fields and discuss prospects for future X-ray survey missions such as eRosita and WFXT.

A Deep X-ray Study of X-ray Binaries in Centaurus A

G. R. Sivakoff and the Centaurus A Very-Large Project Team

University of Virginia Department of Astronomy, P.O. Box 400325, Charlottesville, VA 22904-4325, USA

As the nearest early-type galaxy, Centaurus A contains a treasure trove of information about X-ray binaries. With over 700ks of Chandra observations spread over 10 years, the Centaurus A Very Large Project provides the deepest look at X-ray binaries in an early-type galaxy. Approximately 1000 X-ray sources are detected when the observations are merged, and half are detected individually in at least two observations. Preliminary results have already shed light on the low-mass X-ray binary connection to globular clusters and the discovery of a remarkable transient ultra-luminous X-ray source. We further dip into the trove to present new results on the entire population of sources. These include a comparison of the luminosity functions of XRBs associated with/without globular clusters, preliminary variability results, and follow-up observations on the transient ULX.

A census of X-ray nuclear activity in nearby galaxies

W.M. Zhang[1], *R. Soria*[2]

[1]Physics Dept. and Center for Astrophysics, Tsinghua University, Beijing 100084, China
[2]MSSL, University College London, Holmbury St Mary, RH5 6NT, United Kingdom

We have studied the X-ray nuclear activity of 187 nearby (d < 15 Mpc) galaxies with *Chandra*. We found that 86 of them have a point-like X-ray core, and argue that the majority of them are accreting nuclear BHs, rather than X-ray binaries. The fraction of galaxies with an X-ray detected nuclear BH is higher (~60%) for ellipticals and early-type spirals (E to Sb), and lower (~30%) for late-type spirals (Sc to Sm). In particular, we show that *Chandra* studies are one of the best ways to identify weakly active BHs in the starforming nuclear regions of late-type galaxies, and hence to determine what fraction of them contains a supermassive BH. There is no preferential association of active nuclei with a large-scale bar; in fact, strongly barred galaxies appear to have slightly lower detection fraction and luminosity for their nuclear X-ray sources, compared with non-barred or weakly barred galaxies of similar Hubble types. We discuss the cumulative luminosity distribution and Eddington ratios of the nuclear sources. The intrinsic absorption is lower for the less luminous sources, with L_X <~ 10^{39} erg/s. The lack of a dusty torus may be directly related to the lack of a standard accretion disk around those faint nuclear BHs. The fraction of obscured sources increases with the nuclear BH luminosity, up to ~10^{41} erg/s: this is contrary to the declining trend of the obscured fraction with increasing luminosity, observed in more luminous AGN.

Correlation of ultraluminous X-ray sources with star-forming regions

D.A. Swartz[(1)], A.F. Tennant[(1)], R. Soria[(2)]

[(1)]NASA Marshall Space Flight Center, VP62, Huntsville, AL, USA
[(2)]MSSL, University College London, Holmbury St Mary, RH5 6NT, United Kingdom

We used *Chandra* to study a volume-limited (d < 15 Mpc) sample of ~ 100 galaxies with at least a minimum amount of star formation. We discuss statistical properties of their ULX population. In particular, how the number of ULXs correlates with the total star-formation rate and size of their host galaxies. Within each galaxy, we used Sloan Digitized Sky Survey images to show that ULXs correlate with star-forming regions, but have no preferential correlation with massive star clusters. Moreover, we used *Chandra* to study a subsample of slightly more distant galaxies with much higher star formation rates: we discuss whether the ULX luminosity function (which is the extension at high luminosities of the high-mass X-ray binary luminosity function) has a break at L_X~ 2E40 erg/s (which can still be consistent with stellar-mass black holes), or extends unbroken at least up to L_X~ 1E41 erg/s (which would probably require the existence of intermediate-mass black holes).

The deep XMM-Newton survey of M 31

H. Stiele , W. Pietsch, F. Haberl for the XMM-Newton M 31 large program collaboration

Max-Planck-Institut für extraterrestrische Physik, Giessenbachstraße, Postfach 1312, 85741 Garching, Germany

The deep, homogeneous XMM-Newton survey of the large local-group spiral galaxy M 31 is a milestone project for X-ray astronomy, as it allows a detailed X-ray inventory of an archetypal low-star-formation-rate galaxy like our own. The full survey, which covers the entire D_{25} ellipse, contains 1951 X-ray sources. Using hardness ratios, extent, temporal variability, and cross correlations with optical and radio source catalogues, we identified 43 supersoft sources, 25 supernova remnants, 38 supernova remnant candidates, 10 X-ray binaries, 22 X-ray binary candidates, 36 X-ray sources located in globular clusters and 17 X-ray sources in globular cluster candidates. In addition we found 269 foreground stars and 79 background objects.

Within the class of SSSs we found 13 novae and 3 sources that are persistent for at least one decade. The spatial distribution of the SNRs is closely correlated with the star forming regions in M 31.

The analysis of the number of sources at energies > 2 keV did not reveal global differences between the eastern and western side, or between the northern and southern part of the galaxy. We analysed the radial dependence of the source density. A comparison of the number of sources in the M 31 field with deep fields from the literature shows that about 53% of the sources with $F_x > 3.2\ 10^{-14}$ erg cm^{-2} s^{-1} should be background sources.

The nature of low luminosity X-ray galaxies

M. G. Watson, Y. Xu, G.C. Stewart

University of Leicester, Leicester, UK

We have selected a large new sample of X-ray emitting galaxies at intermediate redshifts (z~ 0.01 – 0.5) from a cross-match of the 2XMMi X-ray and the SDSS DR7 optical spectroscopic catalogues. The sample is dominated by galaxies with lower X-ray luminosities ($10^{40} < L_X < 10^{43}$ erg s^{-1}), effectively because of the magnitude limit for SDSS spectroscopy. Our sample consists of ≈ 500 X-ray emitting galaxies, the largest such ever assembled, and covers both lower luminosity AGN and "normal" galaxies powered by stellar processes. We use optical line ratios*, optical morphology and colours, X-ray hardness ratios and other indicators to classify the galaxies and constrain the underlying X-ray emission mechanisms. We also investigate the correlations of derived galaxy masses* and star formation rates* with the X-ray properties. Our large sample allows us to explore how the AGN-powered contribution varies with key parameters such as X-ray luminosity, galaxy morphology and line-ratio galaxy classification. We find that a large fraction of the sample are in fact consistent with being AGN-powered, or having a significant AGN component, even at the lowest luminosities. We also present new results on the properties of specific subsamples, such as the Seyfert 2s, LINERs and star-forming galaxies.

* these parameters taken from the MPA/JHU DR7 spectroscopic catalogues: http://www.mpa-garching.mpg.de/SDSS/

A “Pandora box” of galaxies

A. Wolter,[1] *A. Fruscione*[2]

[1]INAF-OABrera, Milano, Italy
[2]SAO-CfA, Cambridge MA, USA

We present XMM-Newton observations of three high X-ray luminosity "normal" galaxies: MS1204.1+2826 (NGC4104), MS1143.6+2040 (NGC3884) and MS1309.1+3208. These objects are part of a flux limited sample of 8 high X-ray luminosity galaxies from the Einstein Medium Sensitivity Survey. In addition to these three objects, three others in the sample have already been observed by XMM-Newton and Chandra. We will present the details of our new observations and analysis and compare the properties of these objects with the rest of the sample and with the high X-ray luminosity normal galaxies in the deep surveys.

The observations were done with the aim of confirming that high X-ray luminosity normal galaxies discovered in deep XMM-Newton and Chandra survey and classified as new classes of exotic objects were already present in earlier and much brighter samples, and that this "unusual" populations appearing at low X-ray fluxes are actually the low-flux counterparts of the nearby and X-ray bright "galaxies" that have been known for two decades. The data we will present are confirming this view.

Multi-wavelength Observations of Sgr A*

F. Yusef-Zadeh

Dept Physics and Astronomy, Northwestern University, Evanston, IL. 60208, USA

In the last several years, we have been coordinating a number of telescopes in order to understand the correlation and the radiation mechanism of flare emission in different wavelength bands.
These measurements should have implications in the underluminous nature of Sgr A*. Here, we highlight the results of observations made during 2007, 2008 and 2009. These observing campaigns have included XMM, Chandra , HST and numerous other ground based telescopes in radio and submillimeter wavelengths. We show strong flares in X-rays and infrared wavelengths which are coincident with each other with no time delay. However, radio flares are time delayed with respect to the peaks of infrared and X-ray flare emission. Modelling of X-ray and near-IR flares suggest that ICS is responsible for the origin of X-ray emission. We also argue a model in which hot expanding plasma iin the disk of Sgr A* is adiabatically cooling. One of the consequences of the adiabatic cooling of hot plasma is that optically thick gas should show a time delay as a function of frequency. Model fitting of the light curves supporting this picture will be presented.

Luminosity function of low mass X-ray binaries in globular clusters in nearby galaxies

Z. Zhang

Max-Plank-Institute of Astrophysics, Karl-Schwarzschild-Str. 1 - 85741 Garching, Germany

We measure the X-ray luminosity functions of the X-ray binary population in nearby early type galaxies (M31, Centaurus A, M81, e.g.) to a limiting luminosity of 10^{35} erg s^{-1}. With the high spatial resolution of *Chandra* we resolve more than 100 X-ray binaries hosted in globular clusters, and compare the combined luminosity function of them with that of field X-ray binaries. With reliable statistics we find a lack of globular cluster LMXBs below ~10^{36} erg s^{-1}. This demonstrates that these two samples have different formation history.

Chandra Multi-wavelength Plane Survey Towards the Galactic Center

P. Zhao[1], *J. Grindlay*[1], *J. Hong*[1], *X. Koenig*[1], *M. van den Berg*[1], *S. Laycock*[2]

[1] Harvard-Smithsonian Center for Astrophysics, Cambridge, USA
[2] Gemini Observatory, Hilo, Hawaii, USA

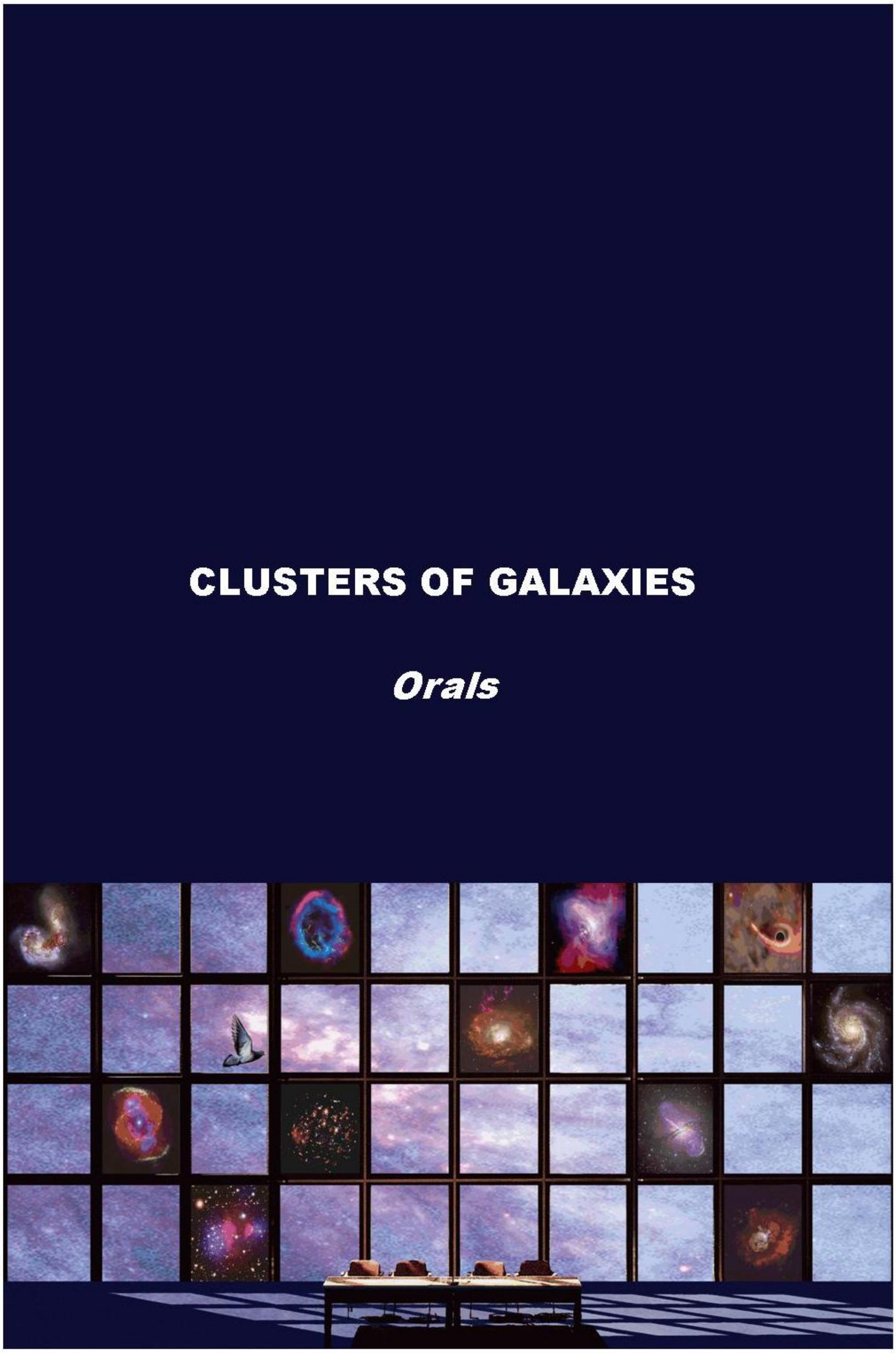
We have been conducting the Chandra Multi-wavelength Plane Survey (ChaMPlane) for the last decade. ChaMPlane is designed to survey the point X-ray sources discovered by the Chandra X-ray Observatory in the galactic plane in order to constrain the X-ray binary population in the Galaxy. This multi-wavelength survey includes the data from the Chandra achieve, as well as the optical and infrared images and spectroscopes. So far we have observed 73 ChaMPlane fields which cover about 25 square degrees and 297 ACIS observations in the galactic plane (AO1-10).

The point X-ray sources detected by Chandra are searched for their counterparts in the deep V, I, R, H-alpha optical and J, H, K IR photometry. Spectroscopic follow-ups are conducted for identified optical counterparts.

The Galactic Center is the dynamic crater of thousands X-ray sources due to its high concentration of CVs, LMXBs and HMXBs. Therefore it's the most intensely studied region of the ChaMPlane survey. The Chandra deep observations (14 obsids with a total 750ks exposure time) with ACIS-I revealed 2876 X-ray point sources within 8 arcmin of SgrA* in energy band 0.3-8.0keV.

About 300 of them are detected in soft band (0.5-2.0keV); over 2000 are detected in hard band (2.0-8.0keV).

So far we have found 6 CVs in the Galactic Center region. Combining our optical identification, spectral classification and X-ray quartile analysis we present the results on the classification, estimated NH and distance of the stellar objects responsible for the detected X-ray emissions towards the Galactic Center.


CLUSTERS OF GALAXIES
Orals

Reflections of AGN Outbursts in the Hot Gas in Galaxies and Clusters

C. Jones

Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA, USA

Most galaxies harbor a supermassive black hole at their center. At high redshifts, these galaxies experienced a very active phase, when these black holes produced enormous amounts of energy, likely fueled through galaxy mergers.

Today, some of these supermassive black holes still undergo occasional outbursts that are seen through spectacular jets, cavities and buoyant bubbles and shocks in the surrounding X-ray gas.

In this talk I will review Chandra and XMM-Newton results on AGN outbursts in rich clusters and groups as well as the effects of outbursts in Centaurus A and other elliptical galaxies.

The Intra-Cluster Medium: recent results and future prospects

S. Molendi

IASF - Milano, Italy

The dominant baryonic component in galaxy clusters is in the form of a hot and tenuous plasma known as the Intra-Cluster Medium (ICM).
Although understanding of physical processes in the ICM has improved dramatically over the last decade, much remains to be uncovered.
In this presentation I shall discuss some recent findings and, if time allows, I will also review future prospects.

Chandra Observations of Cooling and Non-Cooling Galaxy Clusters

T. Reiprich

Argelander Institute for Astronomy, Bonn University, 53121 Bonn, Germany

The physics regulating the dense gas at the centers of galaxy clusters is far from being fully understood. Moreover, no comprehensive and systematic census of observed, detailed properties of cluster cores exists up to now. We aim to put the statistical description of cluster centers on a firm new footing in order to: (1) gain insight into the physics governing cluster cores, (2) identify the best parameter for characterizing cool core clusters for given data quality and (3) provide a benchmark for theoretical modeling and numerical simulations of cluster cores. We summarize 16 widely used as well as new cool core diagnostics and apply them to the largest complete and well-controlled cluster sample with available high quality data (HIFLUGCS, the HIghest X-ray FLUx Galaxy Cluster Sample, 64 clusters with >4.5 Ms of cleaned Chandra data). Moreover, we correlate the different diagnostics with each other, so that studies of, e.g., the fraction of cool core clusters using various definitions may be compared. Furthermore, the optical and radio properties of the brightest cluster galaxies, as well as implications for AGN feedback in cluster cores are discussed.

Joint X-ray and Sunyaev-Zel'dovich analysis of the intra-cluster gas properties

K. Basu on behalf of the APEX-SZ Collaboration

MPIfR Bonn, Germany

For almost a decade, observations of the thermal Sunyaev-Zel'dovich Effect (tSZE) have been considered as a promising complement to X-ray observations for modeling the physical properties of the intra-cluster gas (ICM) in galaxy clusters. Yet most joint X-ray/SZE combined analyses have been limited to analytical or numerical cluster models, and only recently has it been possible to make meaningful de-projections of gas temperature and density profiles using tSZE imaging data from multi-pixel bolometer arrays in combination with X-ray. I describe our recent and ongoing work combining tSZE data from the *APEX-SZ* experiment with X-ray surface brightness data from *XMM-Newton*. In particular, I demonstrate the advantage of using large-area tSZE maps for non-parametric modeling of the ICM thermodynamics nearly out to the cluster virial radius. I also present results using data from the *Suzaku* satellite: its low particle background allows imaging of the cluster X-ray emission out to large radii, making it an ideal complement to *APEX-SZ* imaging. I discuss the different sources of systematic errors in the joint X-ray/SZE modeling, as compared to the X-ray spectral analysis method.

3C28 in Abell 115 - A Radio Source With a Twist: Tracing Gas Vortices in a Merging Subcluster Core

W. Forman[(1)], *E. Churazov*[(2,3)], *S. Giacintucci*[(1)], *S. Heinz*[(4)], *C. Jones*[(1)], *M. Markevitch*[(1)], *A. Vikhlinin*[(1)], *R. Johnson*[(1)], *R. Kraft*[(1)], *M. Murgia*[(5)], *S. Randall*[(1)], *L. David,*[(1)]

[(1)]CFA/SAO, 60 Garden St., Cambridge, USA
[(2)]IKI, Profsoyuznaya 84/32, Moscow, Russia
[(3)]MPA, Karl-Schwarzschild-Strasse 1, Garching, Germany
[(4)]University of Wisconsin, Madison, USA
[(5)]INAF, Via P. Gobetti 101, Bologna, ITALY

Abell 115 is a "bimodal" X-ray cluster first classified from Einstein Observatory X-ray images. The X-ray image is dominated by emission from two subclusters, separated by ~900 kpc, that are in the process of merging. The northern subcluster (hereafter, A115-N) contains a bright central galaxy that hosts the radio source 3C28 that exhibits a remarkable morphology. 3C28 shows no evidence of an active nucleus, has two prominent jets connected to a pair of radio lobes, each of which exhibits a radio tail. We combine Chandra X-ray and VLA radio observations to study the gas motions in and around A115-N that hosts 3C28. We present a spectral index map derived from multi-frequency VLA observations. We use Chandra data to derive the velocity of A115-N with respect to the ambient intracluster medium as well as the velocity of the gas within the subcluster A115-N. We show that the motion of A115-N through the cluster induces counter-rotating vortices in the subcluster gas that give rise to the unique morphology of 3C28 with its two radio tails pointing in the direction of motion for A115-N. We compare the X-ray gas circulation time within A115-N with the timescale computed from the spectral aging of the radio-emitting plasma. We discuss the implications of these observations for the lifetimes of radio sources in gaseous atmospheres and speculate on the effects of magnetic draping in moving subclusters.

X-ray tails, intracluster ULXs and star formation

M. Sun[(1)], *E. Roediger*[(2)], *P. E. J. Nulsen*[(3)], *M. Donahue*[(4)], *C. Jones*[(3)], *W. Forman*[(3)], *M. Voit*[(4)]

[(1)]University of Virginia, Department of Astronomy
[(2)]Astrophysics Group, Jacobs University Bremen, P. O. Box 750 561, 28725 Bremen, Germany
[(3)]Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138
[(4)]Department of Physics and Astronomy, Michigan State University, East Lansing, MI 48824

The intracluster medium (ICM) has long been proposed to play a vital role in galaxy evolution in clusters. We review the recent observational evidence of the ICM-ISM interaction for cluster late-type galaxies, especially in the X-ray and Hα bands. Spectacular X-ray tails have been observed, with unambiguous evidence of intracluster star formation and ultraluminous X-ray sources.
We will especially discuss the new 140 ks Chandra observation of ESO137-001 and its double tails. Results from Gemini, SOAR and Spitzer observations will also be present. The multi-wavelength data are also compared with recent simulations and we conclude that the new data present challenge to these simulations. Our results suggest that the stripped cold ISM of late-type galaxies will light up in X-rays, in the stage that they are mixing into the hot ICM. On the other hand, a fraction of stripped ISM is able to cool and form stars and eventually compact objects like X-ray binaries in the intracluster space. We will also discuss the “missing HI” problem associated with cluster late-type galaxies and emphasize the importance of multi-wavelength observations on this problem.

Non-thermal emission and very hot component in clusters of galaxies

K. Nakazawa

The University of Tokyo, 7-3-1, Hongo, Bonkyo-ku, Tokyo, 113-0033, Japan

Observation of non-thermal X-ray emission from clusters of galaxies provides direct measure to probe the particle acceleration within the cluster vicinity and strength of the inter-galactic magnetic field combined with radio observations. Following the detection reports from the Coma cluster by Beppo-SAX (Fusco-Femiano et al. 1999, 2004) and RXTE (Rephaeli et al. 2002), many reports are provided. I will review the results by new generation observatories, such as INTEGRAL, Swift-BAT, and in particular by Suzaku on this topic. Clusters with the brightest radio halo and relic, Coma and A3667, will be shown in detail.

In addition, I will discuss about the hard X-ray signal from apparently very hot (kT > 20 keV) thermal component, observed mainly by Suzaku from RXJ 1347.5-1145 and A3667 clusters. Nature of this enigmatic very hot component is still unclear, but it is clear that it cannot be in dynamical equilibrium.

Finally, I will review the prospects of hard X-ray surveys by coming hard X-ray facilities, such as NuSTAR (2011-) and ASTRO-H (2014-). In particular, ASTRO-H, also equipped with calorimator and soft-gamma-ray coverage, will provide powerful tool for resolving the gas bulk motion coupled with possibly localized non-thermal and/or very hot component from clusters of galaxies.

The 2009 X-ray view of Galaxy Groups

F. Gastaldello[1,2]*, D. Buote*[2]*, P.J. Humphrey*[2]*, L. Zappacosta*[3]*, F. Brighenti*[4,5]*, W. Mathews*[5]*, J. Bullock*[2]*, P. Temi*[6]*, S. Ettori*[7,8]

[1]IASF-Milano, INAF, via Bassini 15, Milano 20133, Italy
[2]Department of Physics and Astronomy, University of California Irvine, 4129 Frederick Reines Hall, Irvine, CA, 92697-4575, USA
[3]INAF-Osservatorio Astronomico di Trieste, Via Tiepolo 11, 34143 Trieste, Italy
[4]Dipartimento di Astronomia, Università di Bologna, via Ranzani 1, Bologna 40127, Italy
[5]UCO/Lick Observatory, University of California at Santa Cruz. 1156 High Street, Santa Cruz, CA 95064, USA
[6]Astrophysics Branch, NASA/Ames Research Center, MS 245-6, Moffet Field, CA 94035, USA
[7]INAF-Osservatorio Astronomico di Bologna, via Ranzani 1, Bologna 40127, Italy
[8]INFN, Sezione di Bologna, viale Berti Pichat 6/2, 40127 Bologna, Italy

We present mass, entropy and metal abundances radial profiles for 16 relaxed galaxy groups-poor clusters selected among the brightest the Chandra and XMM archives. Two of them are complemented by Suzaku data at larger radii. After accounting for the mass of the hot gas, the resulting mass profiles are described well by a two-component model consisting of dark matter represented by an NFW model, and stars form the central galaxy. We find for the first time that the NFW concentration parameter (c_vir) for groups decreases with increasing M_vir. The mean gas fraction (f_gas = 0.05 +/- 0.01) of the groups measured within an over-density of 2500 is lower than for hot, massive cluster with a larger fractional scatter (sigma_f_gas/f_gas = 0.2) implying a greater impact of feedback processes on groups. This is reflected in the entropy profiles which show striking deviations from self-similarity, large object-to-object variation and a characteristic broken-power-law behavior, unlike more massive clusters. We present the interesting cases of two groups: NGC 5044 and AWM 4. NGC 5044 shows in the inner 10 kpc a pair of cavities together with a set of bright filaments and two sloshing cold fronts, for the first time revealed in a group of galaxies.
AWM 4 is characterized by a combination of properties which seems to defy the paradigm for AGN heating in cluster cores.

AGN feedback in galaxy groups: a joint GMRT/X-ray study

S. Giacintucci [1,2], *J. Vrtilek* [1], *E. O'Sullivan* [1], *S. Raychaudhury* [3], *L. David* [1], *T. Venturi* [2], *R. Athreya* [4], *M. Gitti* [1,5]

[1] Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA 02138, USA
[2] INAF-Istituto di Radioastronomia, via Gobetti 101, 40129, Bologna, Italy
[3] School of Physics and Astronomy, University of Birmingham, Birmingham B15 2TT
[4] Tata Institute of Fundamental Research, National Centre for Radio Astrophysics, Ganeshkind, Pune, 411 007, India
[5] INAF-Osservatorio Astronomico di Bologna, via Ranzani 1, 40127, Bologna, Italy

We present an ongoing study of 18 nearby galaxy groups, chosen for the availability of Chandra and/or XMM-Newton data and evidence for AGN/hot gas interaction. We have obtained high quality 235 and 610 MHz observations at the Giant Metrewave Radio Telescope (GMRT) for all the groups, and 327 and 150 MHz for a few. The observed radio sources are diverse, covering a range of spatial scales and total powers, from classic FR-I to core-halo radio sources. We discuss several interesting cases which exhibit different kind of AGN/intragroup gas interaction, including NGC5044, NGC3411, and AWM4. For AWM4 we present the analysis of a recent 75 ksec Chandra observation, revealing new X-ray structures likely associated with the central radio galaxy. With the help of these examples we show how the combination of X-ray observations with high sensitivity low frequency radio observations, which allow to trace the emission from aged electron populations, can provide a unique insight into the nature of the feedback mechanism in galaxy groups.

AGN Feedback in Galaxy Groups : the Case of HCG 62

M. Gitti[1,2], *E. O'Sullivan*[2,3], *S. Giacintucci*[2], *L. David*[2], *J. Vrtilek*[2], *S. Raychaudhury*[3], *C. Jones*[2], *W. Forman*[2]

[1]University of Bologna, via Ranzani 1, 40127 Bologna, Italy
[2]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA
[3]University of Birmingham, Edgbaston, Birmingham B15 2TT, UK

As a part of an ongoing study of 18 groups of galaxies, initially chosen for the availability of excellent X-ray data and evidence for AGN/ hot gas interaction, we report on the results of an analysis of new XMM and GMRT data of the X-ray bright compact group HCG 62. This is one of the few groups known to possess very clear, small X-ray cavities in the inner regions as shown by the previous Chandra image. The new ~100 ks XMM exposure of HCG 62 combined with the existing ~ 50 ks Chandra image allow us to derive with unprecedented accuracy the radial profiles of temperature, density and various element abundances along the direction of the cavities and in the other radial directions. At higher frequency (1.4 GHz or above) the cavities show minimal if any radio emission, but the radio clearly appears in the new GMRT data at lower frequency (610 MHz and below). We compare and discuss the morphology and spectral properties of the gas and of the radio source. The synergy of X-ray and low-frequency radio observations can provide a unique insight into the nature of the AGN feedback mechanism.

The Evolution of Spiral Galaxies in a Cluster Environment

M. Ehle[(1)], *M.Wezgowiec*[(2)] *et al.*

[(1)]XMM-Newton SOC, ESA-ESAC, P.O. Box 78, 28691 Villanueva de la Cañada, Spain
[(2)]Astronomical Observatory Jagiellonian University, ul. Orla 171, PL 30-244 Krakow, Poland

We present X-ray and radio polarimetric observations of selected Virgo Cluster spiral galaxies: The X-ray extended emission traces hot gas filaments in galactic halos and is sensitive to the environmental effects exerted by interactions inside the cluster, like ram pressure stripping. The radio polarization studies provide clues about alignment, distortion, compression and strength of magnetic fields. When used together, both types of observations constitute an excellent tool for examining disturbances in galactic disks and halos caused by interactions of galaxies with the intracluster medium or between the galaxies themselves. These kinds of phenomena seem to be common in a cluster environment.

CLUSTERS OF GALAXIES

Posters

X-ray properties of the first clusters detected with the South Pole Telescope

K. Andersson

for the SPT collaboration

We present the X-ray properties of seven clusters recently discovered by South Pole Telescope (SPT) using the Sunyaev-Zel'dovich (SZ) effect.
The clusters are located in a 200 sq deg survey area targeted with the SPT during the 2007 and 2008 observing seasons and represent the most significant SPT detections of SZ clusters in the field.
The sample includes multiple objects not previously indentified as clusters of galaxies and these represent the first clusters discovered using the Sunyaev Zel'dovich effect.
The clusters are detected as decrements with greater than 5sigma significance in the high-sensitivity 150 GHz band SPT map.
ICM temperatures, luminosities and mass estimates are presented for the clusters followed up by Chandra to date.
Based on the X-ray data we conclude that the clusters are likely massive (M>5 x 10^14 Msun) systems. We relate the derived X-ray mass proxies to the observed SZ flux.

Scaling Relations and cluster physics from Sunyaev-Zel'dovich Effect and Chandra X-ray measurements of high-redshift galaxy clusters

M. Bonamente[(1)], *M. Joy*[(2)], *J. Carlstrom*[(3)], *D. Nagai*[(4)], *D. Marrone*[(3)]

[(1)]University of Alabama in Huntsville, Huntsville, AL (USA)
[(2)]NASA Marshall Space Flight Center, Huntsville, AL (USA)
[(3)]University of Chicago, Chicago, IL (USA)
[(4)]Yale University, New Haven, CT, (USA)

We present Sunyaev-Zel'dovich Effect (SZE) scaling relations for massive galaxy clusters at high redshift, observed with both the Chandra X-ray Observatory and the centimeter-wave SZE imaging system at the BIMA, OVRO and SZA interferometric arrays. The scaling relations are used to test self-similar models of cluster formation and evolution, and as a baseline for the measurement of masses from SZE surveys.

We will also present initial results on the measurement of cluster masses independently of cosmology, and a method for measuring the sedimentation of He ions in the intracluster medium, using the combination of X-ray and SZE observations of clusters.

Merger events with galaxy-gas separation in the hot galaxy cluster A2163

H. Bourdin[(1)], *M. Arnaud*[(2)], *S. Maurogordato*[(3)], *P. Mazzotta*[(1)], *G.W. Pratt*[(2)], *J.-L. Sauvageot*[(2)]

[(1)]Dipartimento di Fisica, Università degli Studi di Roma "Tor Vergata", via della Ricerca Scientifica, 1, I-00133 Roma, Italy
[(2)]C.E.A., DSM, Irfu, Service d'Astrophysique, C.E. Saclay, F91191, Gif sur Yvette Cedex, France
[(3)]CNRS, UMR 6202 CASSIOPEE, Observatoire de la Côte d'Azur, BP 4229, F-06304 Nice Cedex 4, France

We present a multiwavelength analysis about merger events observable in the hottest Abell galaxy cluster, A2163 (z=0.201). From XMM-Newton and Chandra data, we evidence in particular the westwards motion of a cold gas clump embedded in the hotter ICM of A2163, and delimited by a cold front with bow-shape. Interestingly, we show that this gas clump has been spatially separated from a galaxy subcluster recently detected from optical data (Maurogordato et al., 08). In a similar way to what has been observed in the so-called "bullet cluster", 1E0657-56, we infer from these findings a merging scenario where a supersonic subcluster has been accreted eastwards by a more massive cluster, while his gas content has been spatially segregated from galaxies. Extensively observed at various wavelenghts, A2163 will thus provide us a secondary case study of gas-galaxy separation in a galaxy cluster overcoming major merger events. Confronting both cases of A2163 and 1E0657-56 with each other and idealised N-body simulations should enable us to investigate effects of this rare phenomenon on galaxy, ICM and dark matter properties.

Hard X-ray emission from Galaxy clusters in the Swift-BAT era

N. Cappelluti , *M. Ajello, P. Rebusco*

MPE, Postfach 1312, 85741, Garching Germany

We report the detection of 10 clusters of galaxies in the first year Swift/Burst Alert Telescope (BAT) all-sky survey. This sample, which mostly comprises merging clusters, was serendipitously detected in the 15-55 keV band. We use the BAT sample to investigate the presence of excess hard X-rays above the thermal emission. The BAT clusters do not show significant (e.g., $>=2\sigma$) nonthermal hard X-ray emission. The only exception is represented by Perseus whose high-energy emission is likely due to NGC 1275. Using XMM-Newton, Swift/XRT, Chandra and BAT data, we are able to produce upper limits of the inverse Compton (IC) emission mechanism which are in disagreement with most of the previously-claimed hard X-ray excesses. The coupling of the X-ray upper limits of the IC mechanism to radio data shows that, in some clusters, the magnetic field might be larger than 0.5 μG. We will also anticipate new exciting results from the first 2 years of BAT survey

Metal Abundances in the Cool Cores of Galaxy Clusters

S. De Grandi, *S. Molendi*

INAF-AO Brera, via E. Bianchi, Merate (LC), Italy

We present results from a study of metals in the cool cores of 26 nearby clusters. We have performed a meticulous measure of Fe, Si and Ni abundances including in the error budget a careful evaluation of uncertainties related to instrumental and spectral model systematics. We find that Fe, Si and Ni abundance distributions are characterized by a moderate spread (from 20% to 30%) around their mean values. We have used our estimates of the Si/Fe and Ni/Fe abundance ratios to constrain the relative contribution of type Ia and core-collapsed Supernovae to the enrichment process of the intra cluster medium (ICM). Unlike previous studies we include both uncertainties associated to the observed abundance ratios and the theoretical yields for Si, Fe and Ni. Our analysis shows that the large uncertainties on the yields prevent any precise estimate of the relative contribution of SNIa and SNcc, and that all that can really be said with some certainty is that they both concur to the ICM enrichment process. We finish by discussing how the coming into operation of the first mission carrying a micro-calorimeter, most likely the japanese ASTRO-H, will afford a major advancement in this field.

XMM-Newton view of the chemical evolution in Abell 2052

J. de Plaa[(1)], *Y. G. Grange*[(1)], *J. S. Kaastra*[(1,2)], *N. Werner*[(3)], *A. Simionescu*[(4)], *J. Vink*[(2)], *T. Tamura*[(5)]

[(1)]SRON Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands
[(2)]Astronomical Institute, Utrecht University, The Netherlands
[(3)]KIPAC, Stanford University, 382 via Pueblo Mall, Stanford, CA 94305-4060, USA
[(4)]MPE, Giessenbachstr. 85748, Garching, Germany
[(5)]ISAS/JAXA, 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan

The metal abundances in the hot X-ray emitting gas in clusters of galaxies contain valuable information about the chemical evolution of the universe. The spatial distribution of the elements and their abundance ratios provide indications for the historical supernova type Ia and core-collapse supernova rate. We present results from a deep XMM-Newton observation of the cluster Abell 2052. Because its visibility is only about 20 ks per orbit and the observations suffers from soft-proton flaring, the background treatment for the outer parts of the cluster is challenging. We show the importance of both multi-temperature structure and background modeling for studying abundances up to about 12 arcmin from the core. We discuss the radial distribution of metals in this cluster and the constraints on its enrichment history.

An X-ray Analysis of the Poor Cluster RXJ 0419+0225

R. Dupke[1,2], *K. Nyland*[3], *J. Bregman*[1]

[1]Dept. Astronomy, University of Michigan, Ann Arbor, MI, US
[2]Observatório Nacional, Rua Gal. José Cristino 77, Rio de Janeiro, Brazil
[3]Dept. Physics, New Mexico Tech, Socorro, NM, US

I will present here a combined Chandra and XMM analysis of spatially resolved spectroscopy of the intracluster gas of the coldest cluster in the Dupke-Bregman ASCA sample of galaxy clusters with velocity gradients, RXJ 0419+0225. Despite the well behaved morphology, this nearby (z~0.012) galaxy cluster presents a significant amount of temperature and abundance substructure, including off-center metal “holes”. Chandra analysis suggests the presence of a velocity gradient similar to that found with ASCA, but with smaller magnitude. We discuss different models to explain the multiple phenomenologies found in this cluster.

Confirmation of non-thermal emission from the Ophiuchus cluster with XMM-Newton, INTEGRAL, VLA and GMRT

D. Eckert [(1)], *J. Nevalainen* [(2)]

[(1)]ISDC, Geneva Observatory, 16, ch. d'Ecogia, 1290 Versoix Switzerland
[(2)]Observatory, University of Helsinki, Finland

We present multi-wavelength observations of the bright, nearby Ophiuchus cluster in the X-ray band with XMM-Newton and INTEGRAL and in the radio band with the VLA and the GMRT. We show that a statistically significant excess is found above 25 keV compared to the best thermal model, which we interpret as inverse-Compton scattering of non-thermal electrons with CMB photons. The X-ray observations are complemented with radio observations at several frequencies which reveal the presence of a rather bright mini-halo. Combining the X-ray and radio observations allows us to measure a magnetic field B=0.1 micro G. Based on the morphological and thermal properties of the cluster, we conclude that re-acceleration of relativistic electrons by an old merger is the most probable mechanism to explain the observed properties of the cluster.

The interactions of Virgo Cluster spiral galaxies as seen in X-ray emission and Radio Polarimetry

M. Wezgowiec[1], *M. Ehle*[2] *et al.*

[1]Obserwatorium Astronomiczne Uniwersytetu Jagiellonskiego, ul. Orla 171, PL 30-244 Krakow, Poland
[2]XMM-Newton SOC, ESA-ESAC, P.O. Box 78, 28691 Villanueva de la Cañada, Spain

We present XMM-Newton X-ray emission, as well as Effelsberg and the VLA radio polarimetry observations of selected Virgo Cluster spiral galaxies. Such studies allow to a large extent the examination of perturbances caused by interactions with the cluster ICM, as well as with other galaxies. Extended X-ray emission traces hot gas flows and the level of activity in central star forming regions of galaxies. Radio polarimetry provide information about the magnetic field morphology, which is very sensitive to external distortions, as well as to peculiar gas flow in the interstellar medium. Combined use of X-ray and magnetic diagnostics allows us detailed investigations of perturbances of both disk and halo components of spiral galaxies. Such perturbances, being a result of interactions, are widely observed in the Virgo Cluster environment and provide important clues about the evolution history of cluster spiral galaxies.

Multi-wavelength study of the optically rich galaxy cluster XMMU J1230+1339 at z=0.975

R. Fassbender, H. Böhringer and the XMM-Newton Distant Cluster Project (XDCP) team

Max-Planck-Institut für extraterrestrische Physik, Giessenbachstrasse 1, 85748 Garching, Germany

We present a combined X-ray/SZE/optical imaging & spectroscopic study of the newly discovered massive cluster of galaxies XMMU J1230+1339 at a redshift of z=0.975. The cluster was detected as a serendipitous extended X-ray source in archival XMM-Newton data as part of the XMM-Newton Distant Cluster Project (XDCP) and was subsequently followed-up with VLT spectroscopy, deep multi-band LBT imaging, and with APEX SZE observations. We will discuss and compare the global properties of the system as derived from the different wavelength regimes and present an analysis of the astonishingly rich galaxy population of the cluster.

Supermodel Analysis of Galaxy Clusters

R.Fusco-Femiano [(1)]*, A.Cavaliere and A.Lapi*

[(1)] IASF-Roma/INAF, Via del Fosso del Cavaliere, 100, Roma, Italy

The analysis of clusters belonging to the Cooling Core (CC) and Non Cooling Core (NCC) classes shows how the Supermodel (Cavaliere, Lapi & Fusco-Femiano 2009) is able to fit any shape of the temperature and X-ray brightness profiles through physical parameters and to give remarkable information concerning the dynamical and thermal history of a cluster including its transition time from the stage of fast collapse to that of slow accretion. For CC clusters the Supermodel is able to reproduce the characteristic temperature profile where a peak of T is followed by a decline toward the cluster center, showing that this profile is not related to cooling or cooling flows. The Supermodel analysis evidences also that some of the clusters require the presence of an entropy floor with extension and level depending on the strength and timing of the merger or AGN events that determine the thermal state of their central region. Such an entropy floor allows us to understand very structured temperature profiles shown by some NCC clusters, highlighting that a remnant of the cool core still persists despite the subsequent entropy deposition; thus such clusters may be named Remnant Cool Core (RCC). In addition, the central flatness of the brightness profile shown by these clusters is strictly related to the floor extension.

XMM-Newton follow-up of 3 BeppoSAX-WFC detected Clusters of Galaxies

Y.G. Grange[1], *E. Costantini*[1], *J.J.M. in 't Zand*[1], *J. de Plaa*[1], *J.S. Kaastra*[1,2]

[1]SRON Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands
[2]Astronomical Institute, Utrecht University, PO Box 80000, 3508 TA Utrecht, The Netherlands

Clusters of galaxies are the largest gravitationally bound structures in the Universe. X-ray spectroscopy is a powerful tool to trace the metal abundances inside the intra-cluster gas. Analysis of the spatial distribution of the temperature structure and metal abundances leads to an understanding of the Universe's history on cosmological time scales. We present results of X-ray spectroscopy on three clusters of galaxies (1E ***0811.5-5704, CIZA J0812.5-5714 and CIZA J1601.7-7544***). The data were taken using the EPIC-pn camera on board XMM-Newton. These three sources were selected from the sample of sources detected the BeppoSAX Wide Field Camera. For the analysis, we apply a novel subtraction method for the soft proton background which is very high in our observations. The metallicities and temperatures we find agree with what was found before for previous samples.

X-ray study of the mass profile in the outer region of A1413

A. Hoshino[(1)]*, S. Sasaki, H.Akamatsu, Y. Ishisaki, T. Ohashi*[(1)]*, J. P. Henry*[(2)]*, K. Sato*[(3)]

[(1)]Department of Physics, Tokyo Metropolitan University, 1-1 Minami-Osawa Hachioji-city, Tokyo, 192-0397
[(2)]Institute for Astronomy, 2680 Woodlawn Drive, Honolulu, HI 96822
[(3)]Graduate School of Natural Science and Technology, Kanazawa University, kakuma, Kanazawa, Ishikawa, 920-1192

We present results from X-ray observations of the outer region of thegalaxy cluster A1413 (z = 0.143) with Suzaku. The XIS spectra for four annular regions from 2.7 to 15 arcmin (corresponding to the virial radius) were fitted with single temperature APEC model including absorption, combined with the foreground Galactic component. The measured temperature is about 7 keV at 3 arcmin and drops to about 3 keV in the outermost region, and we estimated the profile of gravitational mass in the outer region of the cluster.
Based on the theoretical estimation by Suto et al. (1998), we compared the profiles of temperature and surface brightness predicted from the NFW model with our observed results. To extend the mass estimation toward the inner region of A 1413, previous Chandra results were combined with the Suzaku results in the courese of the model fitting. Total gravitational mass within the virial radius was found to range from 5 to 7 x 10e+14 solar mass. The polytropic index n is about 2-5. Adiabatic hydrodynamical simulations predict the value of n being around 5. Thus, our results indicate some physical processes affect the temperature profile in the outer region of the cluster.

Elongated X-ray Emisson from Galaxies in Clusters with Chandra

R. Iizuka[(1)], *Y. Maeda*[(2)], *H. Inoue*[(2)]

[(1)]Department of Physics, Faculty of Science and Engineering, Chuo University, 1-13-27 Kasuga, Bunkyo-ku, Tokyo 112-8551, Japan
[(2)]Department of High Energy Astrophysics, Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency (JAXA), 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan

One of the keys to understand the intracluster medium (ICM) associated with the cluster of galaxies is the heavy element. The heavy elements formed in stars are ejected to the galaxy by the supernova, and supplied from the galaxy to the ICM through some kind of mechanisms. However, it has never been well known how a large mount of the heavy elements is supplied from galaxies to ICM, and is distributed to whole clusters. We found 30 kpc elongated X-ray emission from NGC 4388 in the Virgo cluster. The compressed region is possibly detected at the opposite direction of the galaxy. We found that NGC 4388 is consistent with a view that the gas is being interacting with the Virgo ICM. We may find the direct evidence of the ram pressure stripping from NGC 4388. Additionally, we systematically analyzed 27 member galaxies in the Virgo cluster. The elongated X-ray features are found in 10 in the 27 samples. Furthermore, we analyzed 13 other clusters of the temperature of 1 - 10 keV to examine the environment effect to the galaxy gas. We examined the size, the luminosity and the mass of the 25 E/S0 galaxies in the various environments. Every parameter in X-ray gets significantly smaller and fainter as the ambient ICM pressure increases. Since the temperature of the ICM is proportional to the square of the velocity dispersion of galaxies, the trends are fully consistent with the scenario of the ram pressure stripping.

A Galaxy Merger Scenario for NGC 1550 and Other Clusters

M. Kawaharada[(1)], *K. Makishima*[(2,1)], *T. Kitaguchi*[(2)], *S. Okuyama*[(2)], *K. Nakazawa*[(2)], *K. Matsushita*[(3)], *Y. Fukazawa*[(4)], *N. Inada*[(1)], *S. Konami*[(1)], *P. Gandhi*[(1)], *T. Misawa*[(1)], *K. Ota*[(1)], *R. Takahashi*[(1)]

[(1)]RIKEN, 2-1 Hirosawa Wako, Saitama, Japan
[(2)]The University of Tokyo, 7-3-1 Hongo Bunkyo-ku, Tokyo, Japan
[(3)]Tokyo University of Science, 1-3 Kagurazaka Shinjuku-ku, Tokyo, Japan
[(4)]Hiroshima University, 1-3-1 Kagamiyama, Higashi-hiroshima, Japan

We compared spatial distributions of metal mass, ICM mass, total mass and galaxy light in a galaxy group NGC 1550, using data of XMM-Newton and Two Micron All Sky Survey (Kawaharada et al. 2009). We found that the iron mass-to-light profile (silicon and oxygen mass-to-light ratio profiles as well) exhibits about 2 orders of magnitude decrease toward the center. Further studies comparing mass densities of metals with those of the other cluster components reveal that the iron (as well as silicon) in the ICM traces very well the total gravitating mass, whereas the stellar component is significantly more concentrated to within several tens of kpc of the NGC 1550 nucleus. Thus, in the central region, the amount of metals is significantly depleted for the luminous galaxy light. Among a few possible scenarios, the most likely one is that galaxies in this system were initially much more extended than today, and gradually fell to the center and merged into a central galaxy. We also studied other 11 galaxy clusters, and obtained similar results to NGC 1550, suggesting that the spatial evolution of galaxies is common in galaxy clusters. We have started a project aimed at directly observing the redshift dependence of the galaxy spatial distribution, using data of XMM-Newton, Suzaku, and Sloan Digital Sky Survey. The first results of this project will be also reported.

Spiral-like structure in the core of nearby clusters of galaxies

T. F. Laganá, F. Andrade-Santos, G. B. Lima Neto

Departamento de Astronomia, Universidade de São Paulo, Rua do Matão, 1226, Cidade, Universitária, São Paulo, Brazil.

Not surprisingly, with the very high angular resolution of the *Chandra* telescope, results revealed fairly complex structures in cluster centers to be more common than expected. It is not yet well known how this specific pattern is formed or maintained.

In particular, understanding the nature of these spiral-like feature at the center of some clusters is the major motivation of this work. We present results from *Chandra* deep observations of 15 nearby galaxy clusters ($0.01<z< 0.06$).

Using X-ray temperature and substructure maps, we detect a plume-like feature in the core of 8 clusters. This particular pattern is similar to those found in numerical hydrodynamic simulations of cluster merger with nonzero impact parameter. However, in some clusters of our sample a strong radio source also occupies this region, and there is some correspondence between the two.

We detect a plume-like feature in more than 50% of the clusters in our sample: A85, A426, A496, Hydra A cluster, Centaurus, A1644, A2052 and Ophiuchus.

Our investigation lends support to the fact that these patterns are due to off-axis minor mergers.

These features of high density may confine radio emission from the central galaxy producing, in some cases, amorphous radio morphology.

Large Scale Environment of Massive Galaxy Clusters with z<0.8

M. Lerchster[1,2], *A. Finoguenov*[2], *F. Brimioulle*[1] *et al. 2009*

[1]University Observatory Munich, Ludwigs-Maximillians University Munich, Scheinerstr. 1, 81679 Munich, Germany
[2]Max-Planck-Institut for extraterrestrial Physics, Giessenbachstraße, 85748 Garching, Germany

We present results from our multi-wavelength studies of a sample of massive clusters of galaxies, using multi band wide-field and multi-object spectroscopy observations from ground, as well as pointed observations from space with the Hubble SpaceTelescope (HST) and with the XMM-Newton/Chandra X-ray observatory. We use PHOTO-z, a bayesian photometric redshift code and unique set of semi-empirical SEDs to derive the redshifts on the available U,B,V,R,I,Z and/or u*,g',r',i',z' images. We apply a strong & weak lensing analysis to the deep, 2.5' x 2.5' F606W/F814W band ACS@HST image and 60' x 60' r'-band MegaPrime@CFHT image, respectively. Finally we fit the observed shear with a Single-Isothermal-Sphere (SIS) and a Navarro-Frenk-White (NFW) model to obtain the velocity dispersion and the mass, respectively.
In addition we apply the mass-aperture (MAP) technique to the observed shear to derive the two dimensional dark matter mass distribution of the cluster. Beside the optically data we use X-ray observations to model the mass, based on the temperature and density distributions of the intracluster medium by using a deprojection method.

Chandra results on the shock front in the merging cluster A520

M. Markevitch

SAO, Cambridge, Mass., USA

I will present results from the recent extra-deep Chandra exposure of the second example of a merger bow shock, that in Abell 520. The results include a verification of the constraint on the electron-ion equilibration timescale earlier derived from the shock front in the Bullet cluster.

Clusters of galaxies as X-ray calibrators

J. Nevalainen

Helsinki University, Observatory, p.o. Box 14, 00014 University of Helsinki, Finland

I will present results from a working group aiming at examining the calibration of high energy satellites using clusters of galaxies. The work is part of the IACHEC project. Clusters of galaxies are good for calibration purposes, because they are non-variable and thus large samples can be constructed for meaningful statistical analyses based on non-simultaneous observations with different instruments. Preliminary analysis indicates that in the hard X-ray band (2-7 keV) all the studied instruments (XMM-Newton EPIC, Chandra ACIS, BeppoSAX MECS) agree on the spectral shape of the clusters. Also, the nearly calibration-problem-independent temperature measure of FeXXV/FeXXVI emission line ratio agrees within a few % with the continuum-based temperature in the studied relaxed clusters. This opens a possibility for a very powerful calibration tool for the future X-ray missions.

Searching for H-like triple emission from the WHIM around clustered structures in the XMM-Newton COSMOS and E-CDFS fields

F. Nicastro[1,2,3], *M. Conciatore*[3], *M. Elvis*[3]

[1]INAF-OAR, Via Frascati 33, 00040 Roma, Italy
[2]FORTH, Nikolaou Plastira 100, Vassilika Vouton GR - 700 13 Heraklion, Crete, Greece
[3]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138, USA

Several concentrations of X-ray sources (point-like and extended) are present in both the COSMOS and the Extended CDFS (i.e. E-CDFS) fields, at redshifts ≤ 1, tracing Large Scale Structures (LSSs: e.g. Scoville et al., 2007; Gilli et al., 2009; Gilli, 2004).

We present an analysis of these fields in narrow band XMM-*Newton* and *Chandra* ACIS images centered on the OVIIKα, CVKα and NeIXKα triplets at the redshifts of identified LSSs in the COSMOS field, and their stacking, with the aim of maximizing the contrast between the expected WHIM emission and the diffuse background.

We expect the WHIM filaments connecting the virialized structures of these LSSs, to shine in stacked He-like triplet light, so providing, for the first time, a direct image of the filamentary WHIM.

Non-detection of emission in stacked images and spectra extracted from area surrounding the detected LSS concentrations, will instead provide stringent limits on the density of the line-emitting X-Ray emitting WHIM in these regions.

A panchromatic search for clusters at large cosmological distances with GROND

D. Pierini, H. Boehringer, R. Fassbender, R. Suhada

Max-Planck-Institut fuer extraterrestrische Phyisik (MPE), Giessenbachstrasse, Postfach 1312, 85741 Garching bei Muenchen, Germany

We present preliminary results on the identification of the optical counterparts of two statistical samples of X-ray selected candidate clusters at intermediate/high redshifts with GROND, the MPE 7-channel (grizJHK) imaging camera mounted at the MPG/ESO 2.2m-telescope at La Silla, Chile. The first sample is extracted from a serendipitous all-sky survey built out of deep archival XMM-Newton observations; the second one corresponds to a 6 deg^2 survey area targeted by 3 Sunyev-Zel'dovich Effect experiments and XMM-Newton. In particular, we present depth, efficiency, and strategy of the ongoing follow-up observations with GROND, which aim at obtaining photometric redshifts, star-formation modes and stellar masses of the group/cluster member galaxies brighter than K=20 (Vega). Optical morphology and color-magnitude diagrams in several bands are also illustrated for a few test cases. The contribution of analogous instruments to GROND in the context of present and future studies on observational cosmology with galaxy clusters and galaxy evolution in groups/clusters since redshift ~ 1.5 is discussed.

Gas Bubbles and Sloshing in the Galaxy Group NGC 5098

S.W. Randall[1], *C. Jones*[1], *M. Markevitch*[1], *E.L. Blanton*[2], *P.E.J. Nulsen*[1], *W.R. Forman*[1]

[1]Harvard-Smithsonian Center for Astrophysics, 60 Garden St., Cambridge, MA, USA
[2]Institute for Astrophysical Research, Boston University, 725 Commonwealth Ave., Boston, MA 02215, USA

We present results from Chandra observations of the galaxy pair and associated galaxy group NGC 5098, and find evidence for both gas sloshing and AGN heating. The X-ray brightness images show diffuse emission with a spiral structure, centered on NGC 5098a, and a sharp edge in the diffuse emission surrounding much of the galaxy at about 30 kpc. The spiral structure in the X-ray surface brightness and temperature maps, the offset between the peak of the cool gas and the central AGN, and the structure of the cold front edges all suggest gas sloshing in the core. The most likely perturber is the nearby galaxy NGC 5098b, which has been stripped of its gaseous atmosphere. Detailed images of the core reveal several X-ray cavities, two of which correlate with radio emission and have bright X-ray rims, similar to buoyant bubbles seen in the ICM of other systems. We estimate the pressures in the bubbles and rims and show that they are roughly equal, consistent with these being young features. We assume that the other X-ray cavities in the core, which show no correlation with existing radio observations, are ghost cavities from previous AGN outbursts. An estimate of the mechanical energy required to inflate the cavities indicates that it is sufficient to offset radiative cooling of the gas for 15 Myr. Therefore, for a typical cycle time of 10^7 yrs, the central AGN energy output is enough to balance cooling over long timescales.

Cool core remnants in galaxy clusters

M. Rossetti, *S. Molendi*

INAF IASF-MI, Via Bassini 15, Milano, Italy

Galaxy clusters are usually divided by X-ray astronomers into two classes: “cool core” (CC) and “non-cool core” (NCC) clusters, on the basis of their observational properties. The centers of the former contain lower entropy (low temperature and high density) and higher metal abundance than the cores of the latter. The metal abundance excess is consistent with being ejected from the BCG invariably found in these systems.

Much attention has been devoted recently to the origin of this bimodal distribution of clusters. Generally speaking, the question is whether the observed distribution of clusters is due to a primordial division of clusters into the two classes rather than to evolutionary differences during the history of the clusters.

With a systematical analysis, in 12 out of 21 NCC objects we have found regions which have characteristics reminiscent of those in cool cores, namely relatively low entropy gas, albeit not as low as in CC systems, and high metal abundance. We have dubbed these features CC-remnants, since their most likely interpretation is that they are what remains of a cool core after a heating event (AGN giant outbursts in a few cases and more commonly mergers). This shows that at least a fraction of the NCC objects we observe today have undergone a CC phase during their lifes.

Cold fronts in galaxy clusters

S.Ghizzardi, M. Rossetti, S. Molendi

IASF-Milano/INAF, via Bassini 15, Milano, Italy

Cold fronts have been observed in a large number of galaxy clusters.
Understanding their nature and origin is of primary importance for the investigation of the internal dynamics of clusters. To gain insight on the nature of these features, we carry out a statistical investigation of their occurrence in a sample of galaxy clusters observed with XMM-Newton and we correlate their presence with different cluster properties. We have selected a sample of 45 clusters starting from the B55 flux limited sample by Edge et al. (1990) and performed a systematic search of cold fronts. We find that a large fraction of clusters host at least one cold front. Cold fronts are easily detected in all systems that are manifestly undergoing a merger event in the plane of the sky while the presence of such features in the remaining clusters is related to the presence of a steep entropy gradient, in agreement with theoretical expectations. Assuming that cold fronts in cool core clusters are triggered by minor merger events, we estimate a minimum of 1/3 merging events per halo per Gyr.

X-ray Substructures in Clusters of Galaxies

F. Andrade-Santos, G. Lima Neto, T. Laganá

Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Rua do Matão, 1226 CEP 05508-900 - Cidade Universitária, São Paulo / SP, Brasil

We developed a new method to quantify substructures in clusters of galaxies, based on the analysis of the number and intensity of structures detected by an algorithm of the type "friends-of-friends". This analysis was done in a residual image, which is the result from the subtraction of the surface brightness model image, obtained by fitting a bidimensional analytical model with elliptical symmetry, from the X-ray image. Our method was applied to 55 clusters, which were observed by the *Chandra* Space Telescope for more than 10 ks, and that are in the redshift range $0.02<z<0.2$. We obtained the relation of the substructure level with physical quantities, such as metalicity, total mass, luminosity, temperature and redshift. We verified that there is correlation between the substructure level, mass, luminosity and temperature, and that there are no correlation evidences between substructure level, metalicity, and weak correlation with redshift in the studied interval. We suggest that the substructure level is an indicator of halo accretion history, since it scales linearly with mass. We also suggest that that in the last 2 billion years the cluster merger rate has counterbalanced the relaxation they would have experienced in an isolated physical system, once the substructure level presents a weak evolution in the studied redshift range.

Suzaku observations of the metallicity in the intra-cluster medium of groups and clusters of galaxies

K. Sato[1], *K. Matsushita*[2], *Y. Ishisaki*[3], *N. Y. Yamasaki*[4], *M. Ishida*[4], *and T. Ohashi*[3]

[1]Graduate School of Natural Science and Technology, Kanazawa University, Kakuma, Kanazawa, Ishikawa, Japan
[2]Department of Physics, Tokyo University of Science, 1-3 Kagurazaka, shinjyuku-ku, Tokyo, Japan
[3]Department of Physics, Tokyo Metropolitan University, 1-1 Minami-Osawa, Hachioji, Tokyo, Japan
[4]Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagamihara, Kanagawa, Japan

We studied the metal properties of the intra-cluster medium (ICM) in four groups below ~2 keV and three clusters between 2 and 4 keV observed with Suzaku. Based on the spatially resolved spectra, we obtained the precise abundance distributions up to ~0.3 r_{180} for various metals. As a result, we indicated the milder abundance gradients of Si, S, and Fe compared with the gradients of O and Mg in the ICM for the clusters. Observed metal distributions for clusters supports the view that Si and Fe, produced by type Ia supernovae with major contributions, were supplied to whole region uniformly in the ICM, while the galactic winds caused by type II supernovae have made winder distributions of O and Mg. We calculated not only the Fe, but also O and Mg mass-to-light ratios (IMLR, OMLR, MMLR) with both B-band and K-band luminosities for the ICM of the groups and clusters, and compared the values for each object. We measured OMLR and MMLR to the outer region in the ICM for the first time with Suzaku, while the resultant IMLR were consistent with those with ASCA. The dispersions with K-band for each system seem to be milder compared with those with B-band. In addition, the tendency of IMLRs have a flatter distribution compared with that of the OMLRs in r < 0.1 r_{180} region. These may imply that the metal enrichment process in the ICM seems to be similar for each group and cluster.

A3112: Deep High-Resolution Spectroscopy of a Cool Core Cluster

R. K. Smith[1], *R. Mushotzky*[2], *M. Loewenstein*[2], *J. Cottam*[2], *R. Shafer*[2]

[1]Smithsonian Astrophysical Observatory, Cambridge, MA USA
[2]NASA's Goddard Space Flight Center, Greenbelt, MD USA

XMM-Newton and Chandra observations imply some mechanism acting on hundreds of kpc scales feeds energy into cluster gas and inhibits large cooling gas infalls onto central cD galaxies. Although many X-ray observations have been performed at CCD resolution, only a handful have taken advantage of the unique capabilities of the RGS to do high-resolution spectroscopy, due to the long observing times required and the small number of suitable clusters. We will present recently taken high signal to noise (180 ksec) XMM/Newton RGS observations of the cool core cluster A3112, whose compact properties make it an ideal target for studying heating models with the RGS. The centroids and shapes of the strong lines from O and the Fe L-shell, as well as emission from C and N features and searching for Fe XVII and fluorescence lines will determine the physical characteristics in the cool core of A3112.

Search for emission from warm-hot intergalactic medium

Y. Takei[(1)], *T. Ohashi*[(2)], *E. Branchini*[(3)], *E. Ursino*[(3)], *A. Corsi*[(4)], *H. Kawahara*[(5)], *H. Akamatsu*[(2)]

[(1)]Institute of Space and Astronautica Science, Japan Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagamihara 229-8510 Japan
[(2)]Tokyo Metropolitan University, 1-1 Minami-Osawa, Hachioji, Tokyo 192-0397 Japan
[(3)]Univ. Roma Tre, Vasca Navale 84, I-00146 Roma, Italy
[(4)]IASF/INAF Via del Fosso del Cavaliere 100, I-00133 Roma, Italy
[(5)]University of Tokyo, 7-3-1 Hongo, Bunkyo, Tokyo 113-0033, Japan

About half of the baryons in the local Universe are not yet observed and are thought to reside in the intergalactic medium at temperatures of 0.1-10 million K and densities of 10^{-6}-10^{-4} cm^{-3}. This is called warm-hot intergalactic medium (WHIM). Using XIS instrument onboard Suzaku, we searched for redshifted OVII and OVIII WHIM emission lines, in cluster outskirts and superclusters. The chance for detecting a signal was estimated to be sufficient to motivate our search, given the relatively high density and high temperature expected for the WHIM in these regions. We did not detect the significant emission, but obtained upper limits in OVII and OVIII emission intensities. The density of the WHIM was constrained based on the upper limits. Future instruments such as microcalorimeters have much higher sensitivity for weak lines. In particular a combination of a microcalorimeter and large grasp (effective area times field of view) telescope is ideal for mapping of the WHIM. We created mock spectra that contain the WHIM, cosmic X-ray background and Galactic emission. The detectability and expected 3-dimensional map with future missions such as XENIA were investigated. We present both observational results from Suzaku and future prospects based on the results of our simulatios.

A new X-ray Cluster Survey with SWIFT/XRT

P. Tozzi and the SXCS Team

INAF - Observatory of Trieste, via G.B. Tiepolo 11, 34100 Trieste, ITALY

We present a new X-ray cluster survey with the X-ray Telescope (XRT) on board of SWIFT. Thanks to its mirror, XRT is an efficient survey machine, despite its small effective area. From 390 fields in the XRT/SWIFT archive at the date of February 2009, we are able to build a catalog of about 200 extended sources, among which we expect 10-20 clusters at $z>1$. The bright part of this sample, about 40 objects, has been already identified thanks to optical archives like SDSS, or at least has redshift obtained from the X-ray spectrum itself. Such a small sample, with a very well defined selection function and good spectral quality, can provide significant cosmological constraints. This also shows that an X-ray telescope with good spatial resoluition (~5"), flat PSF as a function of the off-axis angle, low background, and large field of view ,is what we need to achieve significant breakthrough in cluster physics and cluster cosmology (not to mention the study of the AGN population and of the Galactic sources).

Multi-wavelength observations of a z ~ 0.9 cluster of galaxies

M. P. Ulmer[1,2], *C. Adami*[1], *G.B. Lima-Neto*[3], *F. Durret*[4], *G. Covone*[5], *O. Ilbert*[1]
E.S. Cypriano[7], *S.S. Allam*[8], *R.G. Kron*[9], *W.A. Mahoney*[10] *and R. Gavazzi*[3]

[1]LAM, P^ole de l'Etoile Site Ch^ateau-Gombert, 38 rue Fr´ed´eric Juliot-Curie, 13388 Marseille Cedex 13, France
[2]Department of Physics and Astronomy, Northwestern University, 2131 Sheridan Road, Evanston IL 60208-2900, USA
[3]Instituto de Astronomia, Geof´ısica e C. Atmosf./USP, R. do Mat˜ao 1226, 05508-090 S˜ao Paulo/SP, Brazil
[4]Institut d'Astrophysique de Paris, CNRS, UMR 7095, Universit´e Pierre et Marie Curie, 98bis Bd Arago, 75014 Paris, France
[5]INAF – Osservatorio Astronomico di Capodimonte, v. Moiariello 16, 80131 Naples, Italy
[6]Institute for Astronomy, 2680 Woodlawn Dr., University of Hawaii, Honolulu, Hawaii 96822, USA
[7]Department of Physics and Astronomy, University College London,Gower Street, London WC1E 6BT, UK
[8]Fermi National Accelerator Laboratory, MS 127, P.O. Box 500, Batavia, IL 60510, USA
[9]University of Chicago, Department of Astronomy and Astrophysics, 5640 South Ellis Avenue, Chicago, IL 60637, USA
[10]California Institute of Technology, Spitzer Science Center, MS 314-6, 1200 East California Blvd, Pasadena , CA 91125, USA

We present a multi-wavelength study on a z ~ 0.9, Cl 1257+4738. The cluster Cl 1257+4738 was found by comparing a ROSAT image with red ground based images, taken to determine if the red galaxies were young dusty ones or old early type galaxies. This adds another cluster to the handful of clusters with z larger than about 0.9. Each one provides new insights as to the relationship between the evolution of galaxies and the ICM. We acquired *Chandra*, *XMM-Newton*, *Spitzer* IRAC plus MIPS 24 data to study this relationship between galaxies and the ICM. The *Chandra* plus *Spitzer* and ground based data gave us the unique opportunity to find candidate galaxies and *AGNs* that could be at redshifts from 3 up to as high as 10. Prospects for future surveys to search for these high z objects will be discussed

Total mass biases in X-ray clusters

R. Valdarnini[1], *R. Piffaretti*[2]

[1]SISSA, Via Beirut 2-4 Trieste ,Italy
[2]CEA Saclay,91191 Gif sur Yvette Cedex,france

We use N-Body/SPH simulations of a large sample of galaxy clusters/groups to study the reliability of total mass estimates from X-ray observations of the intra-cluster medium. From the simulated gas distribution we derive temperature and surface brightness profiles and compute the total gravitational mass assuming hydrostatic equilibrium and spherical symmetry.

The estimated mass is compared to the true cluster mass at various cluster-centric distances, and the X-ray mass bias is computed. We discuss the dependence of the X-ray mass bias on: cluster substructure (as measured from a power ratio analysis of the surface brightness maps), modeling of the gas density and temperature profiles, extrapolation of the mass profile outside the observed radial range, and spectroscopic temperatures. In addition, we investigate the role of non-thermal pressure support by means

Galaxy Clusters: Substructures and Mass Systematics

Y.Y. Zhang

AIfA, University of Bonn, Auf dem Huegel 71, D53121, Bonn, Germany

Numerical simulations point out that X-ray mass proxies do not work equally well at all radii. The origin of the effect is thought to be associated with cluster mergers. Here we present a first attempt to use the study of substructure in assessing the systematics of the hydrostatic mass measurements using two-dimensional (2-D) X-ray diagnostics. The temperature map is uniquely able to identify the substructure in an almost relaxed cluster which would be unnoticed in the ICM electron number density, entropy and pressure maps. We describe the radial fluctuations in the 2-D maps by a cumulative/differential scatter profile relative to the mean profile within/at a given radius. The amplitude indicates ~10% fluctuations in the temperature, electron number density and entropy maps, and ~15% fluctuations in the pressure map. The amplitude of and the discontinuity in the scatter complement 2-D substructure diagnostics, e.g. indicating the most disturbed radial range. There is a tantalizing link between the substructure identified using the scatter of the entropy and pressure fluctuations and the hydrostatic mass bias relative to the expected mass based on the scaling relations.

ACTIVE GALACTIC NUCLEI

Orals

AGN spectroscopy and timing: an XMM-Newton view

G. Miniutti

LAEFF, Madrid (Spain)

The advent of relatively large collecting area X-ray observatories such as XMM-Newton, Chandra and, more recently, Suzaku enabled the X-ray community to perform detailed spectroscopic and variability studies of Active Galactic Nuclei in a manner that was impossible only a decade ago. I review here some of the most recent results in the field, with particular emphasis on what we have been able to learn and understand (and on what is still largely unclear and debatable) about the innermost regions of the accretion flow in supermassive black holes.

Suzaku wide-band observations of black-hole binaries and AGNs: continuum and Fe-K lines

S. Yamada[(1)], *K. Makishima*[(1,2)], *K. Nakazawa*[(1)], *H. Noda*[(1)], *H. Takahashi*[(3)], *T. Dotani*[(4)], *A. Kubota*[(6)], *K, Ebisawa*[(4)], *Y. Ueda*[(5)] *and C. Done*[(7)]

[(1)]The University of Tokyo, 7-3-1, Hongo, Bonkyo-ku, Tokyo, 113-0033, Japan
[(2)]RIKEN, Wako, Saitama, 351-0198, Japan
[(3)]Hiroshima University, 1-3-1, Kagamiyama, Higashi-hiroshima, 739-8526, Japan
[(4)]ISAS/JAXA, 3-1-1, Yoshinodai, Sagamihara, Kanagawa, Japan, 229-8510
[(5)]Kyoto University, Kitashirakawa-Oiwake-cho, Sakyo-ku, Kyoto, 606-8502, Japan
[(6)]Shibaura Institute of Technology, 307 Fukawaku, Minuma-ku, Saitama-shi, Saitama, 337-8570, Japan
[(7)]University of Durham, South Road, Durham, DH1 3LE, England

Suzaku has enabled us to study wide-band spectral and timing properties of black-hole binaries and AGNs more accurately than ever, and revealed how the continuum definition can affect Fe-K line profiles. We have reproduced 0.5—300 keV spectra of Cyg X-1 and GRO J1655-40 in terms of thermal Comptonization in highly inhomogeneous coronae (Makishima et al. 2008, Takahashi et al. 2008). In both objects, the inner radius of disk (Rin) was constrained by the Fe-K line profile and soft excess to be ~ 10 Rg, against the relativistic Fe-K line reported by Miller et al. (2006). We also re-analyzed the 0.7-300 keV Suzaku spectra of GX 339-4, and found that a careful modeling of the continuum leads to Rin > Rg (Yamada et al. 2009 submitted), again disagreed with Miller et al. (2008). Furthermore, we systematically studied 18 bright AGNs and discovered in 3 of them a hard spectral component in HXD-PIN band, which varies independently of the powerlaw. Taking this into account, the time-averaged spectra of MCG–6-30-15 have been explained by invoking neither the large reflection fraction, nor the extreme broad Fe-K line (Uehara et al. 2009 in prep). The essence here is that the hard X-ray (20-40 keV) bump may be partially explained as an extra Comptonization, instead of the usually invoked disk reflection. Our results indicate that the highly relativistic Fe-K line reported for some objects is not a unique solution, and depends in many cases on continuum modeling.

Reflection spectrum and reverberation in NLS1 1H0707-495

A. Zoghbi [1], *A. Fabian*[1], *P. Uttley*[2]

[1]Institute of Astronomy, University of Cambridge, CB3 0HA, UK
[2]University of Southampton, Southampton, SO17 1BJ

Broad iron K line emission has been seen in all types of accreting sources, including AGN, Galactic blackholes and neutron stars. In this work, we report on the first detection of the accompanying broad iron L emission line, expected to be present at ~ 1keV. A long XMM-Newton observation of the Narrow Line Seyfert 1 galaxy 1H0707-495, shows two clear broad features corresponding to K and L lines. This confirms the reflection nature of the spectrum, and indicates that most of the radiation is emitted within few gravitational radii from the black hole.

Furthermore, the strong L line has enabled us, for the first time, to measure a time lag of 30s between the direct and the reflected emissions. The lag is comparable to the light-crossing time at few gravitational radii around the black hole, and is interpreted as a reverberation signal, opening The window for future studies of extreme environments around black holes.

The origin and X-ray Binary analogy of the first AGN QPO

M. Middleton, C. Done, M. Ward

University of Durham, Department of Physics, South Road, Durham, DH1 3LE. UK

The discovery of the first confirmed QPO in an AGN (REJ1034+396) is the missing link in the timing properties of X-ray Binaries (XRBs) and AGN and provides a slow-motion look at the much shorter timescale variability seen in XRBs. By testing the shape of the rapid variability against potential spectral models we can deduce that the QPO has its orgins in the variable, high-energy power law tail which is diluted by low-temperature comptonisation of the disc seed photons. This model fits the energy spectrum extremely well and naturally reproduces the large soft-excess seen in the source. The optical-X-ray SED of REJ1034+396, together with a low mass estimate, suggests that the source is accreting at super-Eddington rates, from which we speculate that the QPO is the analogy of the 67Hz QPO of GRS1915+105, also (probably) seen at super-Eddington accretion rates.

Radiative properties of AGN - lessons from numerical simulations of gas dynamics

D. Proga

University of Nevada, USA

I review recent developments in theoretical studies of radiative properties in AGN. I focus on presenting insights from time-dependent numerical simulations of accretion flows and related outflows.

In particular, I show a few examples of how outflows can affect and help to understand emission in AGN.

A search for relativistic outflows signatures in the X-ray spectra of radio-quiet AGNs

F. Tombesi [1,2], *M. Cappi.* [2], *T. Yaqoob* [3], *J. Reeves* [4], *V. Braito* [5], *G.G.C. Palumbo* [1]

[1]Dept. of Astronomy, University of Bologna, Bologna, Italy
[2]INAF-IASFbo, Bologna, Italy
[3]Dept. of Physics and Astronomy, Johns Hopkins University, Baltimore, USA
[4]School of Physical and Geographical Sciences, Keele University, Keele, UK
[5]Dept. of Physics and Astronomy, University of Leicester, Leicester, UK

Evidence for the presence of relativistic outflows in the inner regions of Seyfert galaxies have been claimed in recent years. This would indicate the existence of winds or ejection of material close to their super-massive black hole, possibly from the accretion disk. In particular, X-ray observations of several sources revealed the presence of absorption lines due to highly ionized iron with blue-shifted velocities of the order of 0.01-0.1c. We present preliminary results of an homogeneous analysis of a complete sample of local bright Seyfert galaxies observed with XMM-Newton. We performed a systematic search for blue-shifted absorption lines in their spectra, in the Fe K band (4-10 keV). This study will help to establish the recurrence of such phenomena and to constrain several parameters, such as the composition and ionization state of the outflow, its overall energetic budget and kinematics.

X-ray, optical and radio variability of AGN: understanding the emission processes

I. McHardy, E. Breedt, P. Arevalo, D. Cameron, T. Dwelly, P. Uttley

School of Physics and Astronomy, University of Southampton, Southampton, UK

Based on our long running RXTE AGN X-ray monitoring programmes, coordinated with optical monitoring from a variety of telescopes, we now broadly understand the complex processes by which optical variations are produced in AGN. Here we review the observations of a sample of AGN including Mkn79, NGC3227, NGC4051, Mkn110 and NGC4593. We show that reprocessing of X-ray emission by the accretion disc is important in all AGN, although to differing degrees, as is intrinsic variation of the accretion disc, probably caused by inwardly propagating fluctuations. In one case there is also evidence for weak reprocessing from the torus. We consider the importance of mass and accretion rate on the relative importance of the above mechanisms. We also present exciting new result based on Swift multiband optical, uv and X-ray spectral monitoring of NGC4395, an AGN with one of the lowest mass black holes known (10^5 solar), where extremely highly correlated variability is seen, as is luminosity-dependent X-ray absorption. Time permitting we may present correlated RXTE X-ray and radio observations of NGC4051, showing that although active radio jets have not yet been found in soft-state binary black hole systems, they are important in soft-state AGN.

A XMM-Newton survey of spectral variability in AGNs: The FERO sample to study the Fe K band variability

G. Ponti et al.

APC Université Paris 7 Denis Diderot, 75205 Paris Cedex 13, France

The nature of the broad Fe K features in the spectra of AGN is still highly debated. Reflection from the accretion disc seems to be the best explanation, but ionised absorption partially covering the nuclear source is a possible alternative. The two models are spectrally degenerate, but predict different variability behaviours. We present a spectral variability study of a sample of the 22 brightest (in the 2-10 keV) unabsorbed AGN.

The Fe K band is investigated through the total and fractional rms spectra that allow to separate the constant and variable spectral components and to pose limits on the two competing models.

Suzaku Broad-band Observations of AGN

Y. Terashima

Ehime University, Bunkyo 2-5, Matsuyama, Ehime 790-8577, Japan

Recent results on Suzaku observations of AGNs are presented. Broad-band coverage and good S/N at high energies of Suzaku are best suited to deompose various spectral components.

The following topics will be discussed; (1) spectral variability and Fe lines in Seyfert 1s,(2) broad band spectra of Seyfert 2s and constraints on the geometry of obscuring matter, and (3) comparison between X-ray properties of optically and X-ray selected obscured AGNs.

Nature of the soft X-ray emission found in LINERs using RGS/XMM-Newton spectra

O. Gonzalez-Martin(1), *M. Guainazzi*(2), *J. Masegosa*(3), *I. Marquez*(3)

(1)Department of Physics and Astronomy, University of Leicester, Leicester, UK
(2)European Space Astronomy Centre of ESA, Madrid, SPAIN
(3)Instituto de Astrofisica de Andalucia (CSIC), Granada, SPAIN

Several families within the AGN have been established from the observational point of view and it is widely believed that a unified model can explain them all under a single scenario. However, this scheme needs to be confirmed since there are several sub-classes of AGN that cannot be easily fitted into it. One of the most intriguing cases are Low Ionization Nuclear Emission line Regions (LINERs). A long debate can be found proposing different physical processes as the main emission mechanism. We have performed a careful study of the X-ray nuclear properties of a sample of 82 of these LINERs (GM+06; GM+09a; GM+09b). Thus, the vast majority of LINERs host an AGN as the main source of energy realized (90%). However, the most important question is still open: How they fit into the unified scenario? One of the most important differences that we find is the thermal component, needed in the vast majority of LINERs (~90%). However, the scatter of the fit seen at soft energies reveal that probably the thermal model is too simplistic. The only way to understand the nature of this soft component is by the use of high resolution spectra. We have analyzed 53 RGS/XMM-Newton spectra of LINER sources. In most of the cases the soft spectra is actually the blending of emission lines, similar to Seyferts. We will discuss the nature of the soft X-ray emission of LINERs and their implication on the unified scenario based on the detected emission lines.

Swift survey of H_2O megamaser galaxies

P. Castangia[(1)], *A. Tilak*[(2)], *M. Kadler*[(3)], *C. Henkel*[(4)], *L. Greenhill*[(2)]

[(1)]INAF-Osservatorio Astronomico di Cagliari, Loc. Poggio dei Pini, 09012 Capoterra (CA), Italy
[(2)]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge MA 02138, USA
[(3)]Astronomisches Institut der Friedrich-Alexander-Universität Erlangen-Nürnberg, Sternwartstrasse 7, 96049 Bamberg, Germany
[(4)]Max-Planck-Insitut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany

While H_2O megamaser radio emission originates from the innermost parsec(s) of active galactic nuclei (AGN), providing a unique way to map accretion disks and to estimate masses of the nuclear engines, X-ray photons are produced in regions even closer to the supermassive central object. An accurate analysis of X-ray spectra allows us to estimate column densities and provides a direct measure of the nuclear activity. H_2O maser sources associated with AGN tend to show a high column density or are even Compton-thick (Madejski et al. 2006; Zhang et al. 2006). Furthermore, in case of masers in accretion disks, the X-ray radiation may shape the molecular disk structure (Tilak et al 2008). However, the statistics of these studies are still poor, because of a lack of X-ray data for most of the known maser galaxies. Here, we present the results of the first complete survey in the X-ray band, performed using Swift, of all known nuclear H_2O maser sources. Our study allow us to clarify, on a firm statistical basis, the interplay between X-ray and maser emission to deepen our knowledge on the innermost regions of active galaxies.

AGN structure from X-ray absorption variability

G. Risaliti

INAF-Arcetri Observatory, Largo E. Fermi 5, Firenze,

I discuss the structure of the circumnuclear medium of AGNs based on recent results from X-ray monitoring campaigns of several bright obscured AGNs, revealing absorption variability on time scales from hours to a few days. These variations are interpreted as due to clouds crossing the line of sight and eclipsing the X-ray source. From the analysis of these events we obtain constraints on the size of the X-ray source, and on the physical properties, size and distance form the center of the absorbing clouds, which turn out to be coincident with the broad absorption line clouds. This suggests a revision of the schemes of AGN structure, and provide a new powerful way to infer the properties of the broad line region through time-resolved X-ray spectroscopy

The Classification of Extragalactic X-ray Jets

D.E. Harris[1], *F. Massaro*[1], *C.C. Cheung*[2]

[1]SAO, 60 Garden St., Cambridge MA 02138, USA
[2]GSFC, Greenbelt, MD 20771, USA

The overall classification of X-ray jets has clung to that prevalent in the radio: FRI versus FRII (including quasars). Indeed, the common perception is that X-ray emission from FRI's is synchrotron emission whereas that from FRII's may be IC/CMB and/or synchrotron.
Now that we have a sizable collection of sources with detected X-ray emission from jets and hotspots, it seems that a more unbiased study of these objects could yield additional insights on jets and their X-ray emission. The current contribution is a first step in the process of analyzing all of the relevant parameters for each detected component for the sources collected in the XJET website (http://hea-www.harvard.edu/XJET). This initial effort involves measuring the ratio of X-ray to radio fluxes and evaluating correlations with other jet parameters. For single zone synchrotron X-ray emission, we anticipate that larger values of fx/fr should correlate inversely with the average magnetic field strength (if the acceleration process is limited by loss time equals acceleration time). Beamed IC/CMB X-rays should produce larger values of fx/fr for smaller values of the angle between the jet direction and the line of sight but will also be affected by the low frequency radio spectral index. Work at SAO is partially supported by NASA grant AR6-7013X.

Evolution of obscured accretion

R. Gilli

INAF - Osservatorio Astronomico di Bologna, Via Ranzani 1, 40127, Bologna, Italy

While the evolution of galaxies and that of supermassive black holes at their centers seem to be tightly connected, the details of this joint evolution are far less understood. Mergers between gas-rich galaxies are believed to trigger nuclear activity, which, before getting powerful enough to clear the surroundings and shine as an unobscured QSO, is thought to be hidden by large amounts of gas and dust. The luminosity function and cosmological evolution of the obscured AGN population are therefore fundamental observables. However, both are still largely unknown, especially at high redshift.

In this contribution I will discuss our current understanding of the evolution of obscured accretion and its relation with that of unobscured accretion. In particular, the most heavily obscured, Compton Thick AGN, which are thought to be abundant but in fact are extremely elusive, will be considered. A number of methods to select Compton Thick AGN will be presented, spanning from ultradeep X-ray observations to detection of high-ionization optical emission lines. Preliminary results from the first half of the 3Msec XMM observation of the Chandra Deep Field South will be presented. The density of heavily obscured AGN obtained with different techniques will be critically discussed and compared with the predictions from current synthesis models of the X-ray background. Finally, the prospects for detection of large numbers of heavily obscured AGN with future planned or proposed X-ray missions will be presented.

The Unified Scheme seen with INTEGRAL detected AGN

V. Beckmann[(1)] *, S. Soldi*[(2)]*, C. Ricci*[(1)]*, J. Alfonso-Garzon*[(3)]*, T.J.-L. Courvoisier*[(1)]*, A. Domingo*[(3)]*, N. Gehrels*[(4)]*, P. Lubinski*[(1,5)]*, J.M. Mas-Hesse*[(3)]*, and A.A. Zdziarski*[(5)]

[(1)]ISDC Data Centre for Astrophysics, Ch. d'Ecogia 16, 1290 Versoix, Switzerland
[(2)]CEA Saclay, SMW/DAPNIA/SAp, 91191 Gif-sur-Yvette Cedex, France
[(3)]CAB/LAEFF, POB 78, 28691 Villanueva de la Canada, Madrid, Spain
[(4)]ASD, NASA Goddard Space Flight Center, Code 661, MD 20771, USA
[(5)]Centrum Astonomiczne im. M. Kopernika, Bartycka 18, 00-716 Warszawa, Poland

The INTEGRAL mission provides a large data set for studying the hard X-ray properties of AGN and allows to test the unified scheme for AGN. We present results based on the analysis of 199 AGN. A difference between the Seyfert types is detected in flatter spectra with higher cut-off energies and lower luminosities for the more absorbed/type 2 AGN. When applying a Compton reflection model, the underlying continua appear the same in Seyfert 1 and 2, and the reflection strength is about R=1 in both cases, with differences in the inclination angle only. A significant correlation is found between the hard X-ray luminosity and the mass of the central black hole in the sense that the more luminous objects appear to be more massive. There is also a general trend for the absorbed sources and type 2 AGN to have lower Eddington ratios. The black hole mass forms a fundamental plane together with the optical and X-ray luminosity.

The unified model for Seyfert galaxies seems to hold, showing in hard X-rays that the central engine is the same in Seyfert 1 and 2 galaxies, seen under different inclination angle and absorption. The fundamental plane links together the accretion mechanism with the bulge of the host galaxy and with the mass of the central engine in the same way in all types of Seyfert galaxies.

The X-ray and Optical Properties of the Swift BAT-detected AGN

L. Winter[1,2], *R. Mushotzky*[3], *C. Reynolds*[4], *M. Koss*[4], *S. Veilleux*[4], *B. Keeney*[2]

[1]Hubble Fellow
[2]CASA/University of Colorado, Boulder, CO, USA
[3]NASA GSFC, Greenbelt, MD, USA
[4]University of Maryland, College Park, MD, USA

The Swift Gamma-Ray Burst satellite has detected a largely unbiased towards absorption sample of local (z ~ 0.03) AGN, based solely on their 14-195 keV flux. In the first 9 months of the survey, 153 AGN sources were detected. The X-ray properties in the 0.3-10 keV band have been compiled and presented based on analyses with XMM-Newton, Chandra, Suzaku, and the Swift XRT (Winter et al. 2009). Additionally, we have compiled a sub-sample of sources with medium resolution optical ground-based spectra from the SDSS or our own observations at KPNO. In this sample of 60 sources, we have classified the sources using standard emission line diagnostic plots, obtained masses for the broad line sources through measurement of the broad H-beta emission line, and measured the [OIII] 5007 angstrom luminosity of this sample. Based on continuum fits to the intrinsic absorption features, we have obtained clues about the stellar populations of the host galaxies. We now present the highlights of our X-ray and optical studies of this unique sample of local AGNs, including a comparison of the 2-10 keV and 14-195 keV X-ray luminosities with the [OIII] 5007 angstrom luminosity and the implications of our results towards measurements of bolometric luminosities.

The Multi-Wavelength Aspect of the Swift BAT AGN Survey

R. Mushotzky[1,3], *L. Winter*[2], *M. Koss*[3], *M. Melendez*[4] ,*R. Vasudevan*[5], *J. Tueller*[1]

[1]NASA/GSFC Code 662 GSFC Greenbelt MD United States
[2] University of Colorado, United States
[3] University of Maryland, United States
[4] NPP Fellow at GSFC
[5] OA Cambridge England

We will present the results of the X-ray, optical, and IR spectral follow-up and optical and UV imaging of the BAT AGN survey focusing on the comparison of these properties with those of optically selected AGN. We present the spectral energy distributions, the x-ray spectral characterization, the relationship of the IR lines to the x-ray continuum, the nature of the host galaxies morphology, star formation rate and color and estimates of the black hole mass and Eddington ratios.

Multiwavelength perspective of AGN evolution

F. Fiore

INAF Osservatorio Astronomico Roma, Roma, Italy

We know today that the build-up and evolution of galaxies and their central Super Massive Black Holes (SMBHs) proceeds hand in hand. Insights into both processes can be gathered by studying the active SMBH phases (the AGN phase), when feedbacks between the SMBH and their host galaxies must be at work. In this framework the search and study of obscured AGN at high redshift plays a crucial role. On one side it helps the completion of the AGN census and its evolution over the cosmic time. On the other side it allows the investigation of a crucial, early phase of AGN activity, when a large quantity of cold matter in the inner galaxy regions is still available to both feed the nucleus and efficiently absorb the AGN light, setting the onset of the AGN feedback.

I will discuss synergies between X-ray and infrared observations to select unobscured and highly obscured AGN up to z~6, present the status of this research and the prespectives for the next years, when breakthrough facilities such as ALMA and JWST and the next generation of X-ray satellites will be at work.

Infrared-Excess sources at z~2: Compton Thick QSOs or moderately obscured AGN?

A. Georgakakis[(1)], *K. Nandra*[(2)], *M. Rowan-Robinson*[(2)], *P. G. Perez-Gonzalez*[(3)]

[(1)]National Observatory of Athens
[(2)]Imperial College London
[(3)]Universidad Complutense de Madrid

We explore recent claims for the detection of a large population of powerful ($Lx>10^{44}$erg/s) Compton Thick ($N_H>10^{24}cm^{-2}$) QSOs at z~2 among "infrared-excess" sources with 24-micron over R-band flux ratio $f_{24}/f_R>1000$ (e.g. Fiore et al. 2008; Daddi et al. 2007). The multi-wavelength data in the AEGIS and the Chandra Deep Field North (CDF-N) surveys are used to select sources with spectroscopic redshifts at z~1 and with Spectral Energy Distributions, which if redshifted to z~2, would have *observed* $f_{24}/f_R>1000$ (i.e. the selected sources would have been identified as "infrared-excess" galaxies at z~2). The advantage of our approach is that the selected sources are relatively bright at all wavelengths, including X-rays, thereby allowing detailed study of their nature. It is found that a large fraction (e.g. ~80% in the CDF-N) of the sources in the sample are detected at X-rays, suggesting a high fraction of AGN among the "infrared-excess" population. Analysis of the X-ray spectra however, suggests only moderate obscuration ($N_H\sim10^{22}$-$10^{23}cm^{-2}$), well below the Compton Thick limit ($N_H\sim10^{24}cm^{-2}$). Moreover, modelling of the Spectral Energy Distribution of the selected sources shows that the mid-infrared of most of them is dominated by star-formation, with only a small contribution from AGN reprocessed radiation. We conclude that one should be cautious about recent suggestions for the detection of a large population of Compton Thick ($N_H>10^{24}cm^{-2}$) QSOs at z~2. The data in those studies are also consistent with moderately obscured ($N_H\sim10^{22}$-$10^{23}cm^{-2}$) AGN.

The Space Density of Compton Thick AGN

E. Treister[(1)] *and C. M. Urry*[(2)]

[(1)]Institute for Astronomy, Hawaii, 2680 Woodlawn Dr. Honolulu, HI, 96822, USA.
[(2)]Yale center for Astronomy & Astrophysics, P.O. Box 208121, New Haven, CT, 06520, USA.

We constrain the number density and evolution of Compton-thick Active Galactic Nuclei (AGN). In the local Universe we use the wide area surveys from the Swift and INTEGRAL satellites, while for high redshifts we explore candidate selections based on a combination of X-ray and mid-IR parameters. We find a significantly lower space density of Compton-thick AGN in the local Universe than expected from published AGN population synthesis models to explain the X-ray background. This can be explained by the numerous degeneracies in the parameters of those models; we use the high-energy surveys described here to remove those degeneracies. We show that only direct observations of CT AGN can currently constrain the number of heavily-obscured supermassive black holes. Using estimates derived here for the accretion luminosity over cosmic time we estimate the local mass density in supermassive black holes and find a good agreement with available constraints for an accretion efficiency of ~10%. Transmission-dominated CT AGN contribute only ~8% to total black hole growth.

The synergy between deep X-ray and infrared surveys: tracing AGN and star formation activity

D. Alexander

Durham University, Durham, UK

There is great synergy between X-ray and infrared observations in the study of AGN activity in dusty galaxies: X-ray observations provide direct constraints on the luminosity of the primary emission while infrared observations provide information on the dust-reprocessed emission from AGN activity and star formation. With deep X-ray and infrared surveys it is possible to (1) trace the interplay between AGN activity and star formation across cosmic time, (2) place constraints on the properties and evolution of the obscuring material around AGNs (i.e., the putative dusty torus), and (3) potentially identify the most heavily obscured distant Compton-thick AGNs. I will review the current work obtained in these scientific areas and will look towards the advances that we may expect from deep Herschel observations in the future.

QSO winds and galaxy evolution

M.J. Page, F.J. Carrera, J.A. Stevens

(1)UCL Mullard Space Science Lab, Dorking, Surrey, RH5 6NT, UK
(2)IFCA, Santander, Spain
(3)University of Hertfordshire, Hatfield, UK

A significant population of broad-line z=2 QSOs have heavily absorbed X-ray spectra. Submm observations show that these QSOs are embedded in ultraluminous starburst galaxies, unlike most unabsorbed QSOs at the same redshifts and luminosities. The radically different star formation properties between the absorbed and unabsorbed QSOs implies that the X-ray absorption is unrelated to the torus invoked in AGN unification schemes. Instead, these objects represent a transitional phase in an evolutionary sequence relating massive black holes and the formation of galaxies. Prior to this phase, the galaxy is rapidly forming its stars, and the growth of the black hole is obscured. After the X-ray absorbed phase, the naked QSO shines brightly, and its host elliptical galaxy is essentially fully formed. The most puzzling question about these objects has always been the nature of the X-ray absorber. I will present a study of the X-ray absorbers based on deep (50-100ks) XMM-Newton spectroscopy, and show that the absorption is due to a dense, ionised wind driven by the QSO, with a kinetic luminosity compatible with the theoretical requirements for producing the M-sigma relation. I will discuss the implications for the population of X-ray AGN which will be detected by Herschel. Finally, I discuss the potentially paradigm-changing capability of the XEUS cryogenic spectrometer for investigating the role that winds play in QSO and galaxy evolution.

The cosmological evolution of supermassive black holes

A. Marconi

Dipartimento di Astronomia e Scienza dello Spazio, Largo Fermi 2, 50125 Firenze, Italy

The cosmological evolution of supermassive black holes can be inferred either from measurements of black hole masses in large samples of AGN at all redshifts, or from an analysis of the AGN luminosity function. In this talk, I will focus on recent advances in both methods. I will present a new approach to the continuity equation for the black hole mass function which generalizes the method which is now commonly used to analyze the AGN luminosity function and derive BH mass functions. I will also describe recent advances on virial BH mass measurements and their consequences on BH mass functions from direct measurements. Finally, I will present a comparison of the two methods.

On the arcmin structure of the X-ray Universe

J. Ebrero[(1)], *S. Mateos*[(2)], *G.C. Stewart*[(2)], *F.J. Carrera*[(3)]

[(1)]SRON - Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA, Utrecht, The Netherlands
[(2)]Department of Physics and Astronomy, University of Leicester, University Road, LE1 7RH, Leicester, UK
[(3)]Instituto de Fisica de Cantabria (CSIC-UC), Avenida de Los Castros, 39005 Santander, Spain

We present the angular correlation function of the X-ray population of 1063 XMM-Newton observations at high Galactic latitudes, comprising up to ~30000 sources over a sky area of ~125 sq. degrees in three energy bands: soft (0.5-2 keV), hard (2-10 keV), and ultrahard (4.5-10 keV).
This is the largest sample of serendipitous X-ray sources ever used for clustering analysis purposes to date and the results have been determined with unprecedented accuracy. We detect significant clustering signals in the soft and hard bands (~10 sigma and ~5 sigma, respectively), and a marginal clustering detection in the ultrahard band (<1 sigma). We find dependency of the clustering strength on the flux limit and no significant differences in the clustering properties of sources with high hardness ratios (and therefore likely to be obscured AGN) and those with low hardness ratios, implying that both types reside in similar environments and in agreement with the unified model of AGN.
We deproject the angular correlation function via Limber's equation and calculate the typical spatial lengths. We infer that AGN at redshifts ~1 are embedded in dark matter halos with typical masses of log M ~ 12.6 h^{-1} M_{sol} and lifetimes in the range ~3 – 5 x 10^8 years, which indicates that AGN activity is a transient phase in the life of galaxies.

Large Scale structure of the local Universe traced by hard X-ray emitting AGNs

R. Krivonos[1,2], *M. Revnivtsev*[2,3] , *S. Sazonov*[2], *E. Churazov*[1,2], *R. Sunyaev*[1,2]

[1]Max Planck Institute for Astrophysics, Garching, Germany
[2]Space Research Institute, Moscow, Russia
[3]Excellence Cluster Universe, Technische Universitat Muenchen, Garching, Germany

All-sky hard X-ray survey obtained recently with the INTEGRAL observatory provides a unique tool for studying the Large Scale Structure of the local Universe. Obtained sample of hard X-ray emitting AGNs provides the unbiased (free from influence of intrinsic photoabsorption) census of the nearby accreting supermassive black holes. We detect spatial anisotropy of distribution of INTEGRAL AGNs and show that it well correlates with known nearby anisotropies of the matter density distribution. Using AGN sample from INTEGRAL all sky survey we for the first time directly show that the density fluctuations of the matter in the local Universe linearly translates into the density fluctuations of accreting supermassive black holes and measure their zero redshift bias factor. The last is measured to be around unity which implies that SMBH activity is independent from density of galaxies.

Fermi highlights and the gamma-ray/X-ray links

G. Tosti on behalf of the Fermi LAT Collaboration

Dipartimento di Fisica and INFN Perugia, Via A. Pascoli, Perugia, Italy

The Fermi Gamma-ray Space Telescope (formerly GLAST), successfully launched in June 2008, is supporting two science instruments, the Gamma-Ray Burst Monitor (GBM), a near-all-sky detector in the 8 keV to 30 MeV range, and the Large Area Telescope (LAT), a wide field pair-conversion detector sensitive in the 20 MeV to 300 GeV range. The observatory continuously scans the entire sky every three hours with unprecedented sensitivity and source localization. Fermi is opening a new and important window on a wide variety of phenomena, including pulsars, black holes and active galactic nuclei, gamma-ray bursts, the origin of cosmic rays and supernova remnants, dark matter, etc. This talk includes an overview of the mission and a discussion of some of the most exciting early results in the contest of a multiwavelength approach to the study of the different classes of gamma-ray sources.

ACTIVE GALACTIC NUCLEI

Posters

Spectral Energy Distrubutions of Hard X-ray Selected AGN

W. H. Baumgartner[(1)], *J. Tueller*[(1)], *R. Mushotzky*[(1)], *C. Markwardt* [(2)]

[(1)] GSFC/UMBC, Code 661, Goddard Space Flight Center – Greenbelt (USA)
[(2)] NASA Goddard Space Flight Center, Code 661, Greenbelt, MD 20771, USA

The Swift-BAT hard X-ray (14-195 keV) all sky survey is the most sensitive uniform all sky survey in the hard X-ray band. Of the 479 objects detected down to the 1 mCrab level in the first 22 months of data from the survey, approximately half are AGN. These hard X-ray selected AGN are split roughly equally between Type I and Type II AGN. We present here the spectral energy distributions (SEDs) of a subset of the BAT AGN with spectral coverage available in the X-ray (Chandra, XMM, Swift-XRT), UV (Swift-XRT), and IR (2MASS, Spitzer) bands. We discuss correlations between SED properties and AGN observables, including the usefulness of the AGN hard X-ray luminosity as a proxy for the mass of the central black hole.

How complex is the obscuration in AGN? New clues from the Suzaku monitoring of the X-ray absorbers in NGC7582

S. Bianchi[1], *E. Piconcelli*[2], *M. Chiaberge*[3], *E. Jimenez Bailon*[4], *G. Matt*[1], *F. Fiore*[2]

[1]Università degli Studi di Roma Tre
[2]Osservatorio Astronomico di Roma (INAF)
[3]Space Telescope Science Institute
[4]Universidad Nacional Autonoma de Mexico

We present the results of a Suzaku monitoring campaign of the Seyfert 2 galaxy, NGC 7582.
The source is characterized by very rapid (on timescales even lower than a day) changes of the column density of an inner absorber, together with the presence of constant components arising as reprocessing from a Compton-thick material. The best fitting scenario implies important modifications to the zeroth order view of Unified Models. While the existence of a pc-scale torus is needed in order to produce a constant Compton reflection component and an iron K# emission line, in this Seyfert 2 galaxy this is not viewed along the line of sight. On the other hand, the absorption of the primary continuum is due to another material, much closer to the BH, roughly at the distance of the BLR, which can produce the observed rapid spectral variability.
On top of that, the constant presence of a 10^{22} cm^{-2} column density can be ascribed to the presence of a dust lane, extended on a galactic scale, as previously confirmed by Chandra. There is now mounting evidence that complexity in the obscuration of AGN may be the rule rather than the exception. We therefore propose to modify the Unification Model, adding to the torus the presence of two further absorbers/emitters. Their combination along the line of sight can reproduce all the observed phenomenology.

Evolution of AGN seen through the COSMOS survey

A. Bongiorno [1], *A. Merloni,* [1,2], *M. Brusa* [1]

[1]Max Planck Institut fuer Extraterrestrische Physik, Giessenbachstrasse 1, 85748 Garching, Germany
[2]Excellence Cluster Universe, Boltzmannstr. 2, D-85748 Garching, Germany

Active Galactic Nuclei play an important role in many aspects of the modern cosmology and of particular interest is the issue of the interplay between AGN and galaxies and their strong related evolution. Many studies have been done and many results achieved in the last decade but many things remain still unclear and need to be studied using larger sets of data.

The Cosmic Evolution Survey (COSMOS) is currently the largest HST survey ever undertaken (~2 sq.deg). COSMOS observations include also the full coverage of the field with multi-band photometry (from UV, Optical, NIR to MIR and FIR), in combination with a multi-wavelength data-set from radio to X-rays and a spectroscopic coverage obtained using VIMOS, a multi-object spectrograph mounted at VLT.

Using this powerful data-set we explored the properties of a sample of AGN and we studied their evolution also in relation with the evolution of their host galaxy. I will present results achieved in this project.

The deepest hard X-ray survey to date

E. Bottacini, M. Ajello, J. Greiner

Max Planck Insitut fuer extraterrestische Physik, Giessenbachstrasse, Munich, Germany

The Burst-Alert Telescope (BAT) on board the Swift satellite and the Imager on-Board the INTEGRAL Satellite (IBIS) are both coded mask instruments. They represent a major improvement for the imaging of the sky above 15 keV. BAT and IBIS (with its INTEGRAL Soft Gamma-Ray Imager detector - ISGRI) are surveying the extragalactic sky at comparable sensitivity.

We present the results of the SIX survey, the deepest hard X-ray (>15 keV) survey to date which samples fluxes of the order of ~10e-12 erg/cm^2/s. This survey is obtained merging the Swift/BAT and the INTEGRAL/IBIS surveys and allows sampling faint fluxes. In this talk we will show the main results of the survey exhibiting ~100 soruces, focusing on the populations of Seyferts and blazars in particular, and discussing their evolutionary properties. We will also discuss future aspects of the SIX survey and its connection to other missions.

Suzaku observation of NGC4507: another case of a variable absorber

V. Braito, J.N. Reeves, G. Risaliti, R. Della Ceca

University of Leicester, University Road, Leicester, UK

Variability studies of the X-ray absorbing media in Seyfert galaxies has proved to be a fundamental tool to assess the nature and location of the absorbing matter present in the central region of Active Galactic Nuclei. An exciting recent development is the finding that the X-ray spectra of a few obscured AGN change between characteristically Compton-thin and Compton-thick states on relatively short time scales with the most extreme example being NGC1365. This places severe constraints on the geometry and structure of the X-ray absorbing/reprocessing regions and suggests the presence of apparently multiple absorbers/ reflecting mirrors and that the absorber could be inhomogeneous and could have a range of ionization states. We present the Suzaku observation of the Seyfert 1.9 galaxy NGC4507, one of the X-ray brightest Compton-thin Seyfert 2s and a candidate for a variable absorber. Suzaku caught the source in a reflection dominated state.
A comparison with previous X-ray observations shows that NGC4507 changes from transmission to reflection dominated. The pattern of this dramatic spectral variability cannot be simply explained purely by variability of the nuclear activity, but also requires strong variability in the amount of absorption.

Black Hole Growth and Starburst Activity at z=1-4 in the Chandra Deep Field South

M. Brusa [(1)], *F. Fiore* [(2)] *, et al.*

[(1)]MPE- Max Planck Institut fuer Extraterrestrische Physik, Garching bei Muenchen, Germany
[(2)]INAF – Osservatorio astronomico di Roma, Monteporzio Catone, Italy

We present a study of the properties of obscured Active Galactic Nuclei (AGN) detected in the CDFS 1Ms observation and their host galaxies. We limited the analysis to the MUSIC area, for which deep K-band observations obtained with ISAAC@VLT are available, ensuring accurate identifications of the counterparts of the X-ray sources as well as reliable determination of photometric redshifts and galaxy parameters, such as stellar masses and star formation rates. In particular, we: 1) refined the X-ray/infrared/optical association of 179 sources in the MUSIC area detected in the Chandra observation; 2) studied the host galaxies observed and rest frame colors and properties. We found that X-ray selected (L_X=3×10^{42}-10^{45} erg/s) AGN show Spitzer colors consistent with both AGN and starburst dominated infrared continuum; the latter would not have been selected as AGN from infrared diagnostics. The host galaxies of X-ray selected obscured AGN are all massive (M*>10^{10} Msun) and, in 50% of the cases, are also actively forming stars (1/SSFR<t_Hubble) in dusty environments. The median L/LEdd value of the active nucleus is between 3% and 10% depending on the assumed M_BH/M* ratio. Finally, we found that the X-ray selected AGN fraction increases with the stellar mass up to a value of ~30% at z>1 and M*>3×10^{11} M_sun, a fraction significantly higher than in the local Universe for AGN of similar luminosities.

Iron line in the integrated spectrum of serendipitously detected sources in the 2XMM catalog

P. Chaudhary [(1)], *M. Brusa* [(1)], *G. Hasinger* [(2)], *K. Iwasawa*[(3)]

[(1)]Max Planck Institute for Extraterrestrial Physics, Giesssenbachstrasse 1, D-85748 , Garching, Germany
[(2)]Max Planck Institute for Plasmaphysics, Boltzmannstrasse 2, D-85748, Garching, Germany
[(3)]INAF - Osservatorio Astronomico di Bologna, via Ranzani 1, 40127 Bologna, Italy

We exploited the 2XMM catalog and archive products to investigate the properties of the Fe Kα line at different redshifts. We selected 2806 point sources at high galactic latitude (|BII| > 25 degrees) and with the sum of EPIC-PN and EPIC-MOS counts in 0.2-12 keV being greater than 1000. Redshifts of the sources were obtained for 921 sources from Nasa's Extragalactic Database. Individual source spectra are stacked in different luminosity bins over the range $0.01<z<=5$. Preliminary analysis clearly shows that a strong broad Fe Kα line of equivalent width ~200 eV is present at low redshifts ($z<1$). We also find consistent evidence for the X-ray Baldwin effect.

Obscured AGN: the EXIST view of the hidden side of the Universe

R. Della Ceca[1], P. Coppi[2], A. Caccianiga[1], L. Foschini[1], J. Grindlay[3], P. Severgnini[1] and G. Tagliaferri[1] on behalf of the EXIST collaboration.

[1] Osservatorio Astronomico di Brera, Milan, Italy
[2] Yale University, Yale, USA
[3] Harvard CfA, Harvard, USA

Active Galactic Nuclei, powered by accretion onto a Super-massive Black Hole (SMBH), emit over the entire electromagnetic spectrum. Besides being sources where high energy physical processes take place, it is now emerging that they are leading actors in the formation and evolution of galaxies and, in general, of cosmic structures in the Universe. Unfortunately the largest fraction of the AGN population is obscured by a large amount of cold matter around the Active Nuclei that does not permit a direct view to the central energy source below 10 keV. These obscured sources are fundamental for our understanding of the galaxy evolution and of the SMBHs history as the large majority of the energy density generated by accretion of matter in the Universe seems to take place in obscured AGN. We will show here the big steps forward expected from the EXIST mission regarding the real census of SMBH in the Universe (by revealing and measuring heavily obscured accretion) and the physics on how SMBH accrete and interact with the surroundings (by studying the broad-band X-ray spectra).

AGN activity and Obscured Star Formation as a Function of the environment in COSMOS

C. Feruglio[1] *, F. Fiore, F. Civano, H. Aussel, E. Le Floc'h et al.*

[1]Laboratorie AIM, DSM/Irfu/Service d'Astrophysique, CEA Saclay, F91191 Gif sur Yvette

Galaxy interactions, and in general galaxy environment, are expected to play a role in triggering both AGN and star-formation activity in the standard Lambda CDM framework. We have selected a sample of AGN in X-rays in the COSMOS survey, and a sample of star-forming galaxies in the mid-infrared, so to avoid any bias due to obscuration.Taking advantage of the deep multiwavelegth photometric coverage and of the excellent quality of photometric redshifts in COSMOS, we study the environment of AGN up to z~1.2. I will discuss the AGN fraction in different environments, comparing AGN hosted in star-forming galaxies with those in passive galaxies, and AGN with high accretion rate with those with low accretion rate.

Synergetic Fermi-Swift observations of the distant and flaring blazar PKS 1502+106

S. Ciprini, [1,2], *P. Bruel, T. Burnett, E. Cavazzuti, T. Cheung, L. Costamante, L. Foschini, L. Fuhrmann, N. Gehrels, S.Germani, M. Giroletti, S. Healey, M. Kadler, M. Kerr, B. Lott, G. Madejski, E. Massaro, W. Max-Moerbeck, N. Mazziotta, T. Mizuno, V. Pavlidou, T. Pearson, A. Readhead, J. Richards, D. Sanchez, M. Stevenson, H. Takahashi, A. Tramacere, G. Tosti, P. Ubertini, H. Yasuda, J.A. Zenzus; for the Fermi LAT Collaboration E. Angelakis, T. Hovatta, E. Hoversten, Y. Ikejiri, H. Katagiri, K.S. Kawabata, Y.Y. Kovalev, Yu.A. Kovalev, T.P. Krichbaum, M.L. Lister, A. Lähteenmäki, N. Marchili, P. Ogle, C. Pagani, A.P. Pushkarev, K. Sakimoto, M. Sasada, M. Uemura, M. Yamanaka, T. Yamashita.*

[1]Physics Dept., University of Perugia, & INFN Perugia, via Pascoli, 06123 Perugia, Italy.
[2]Tuorla Observatory,University of Turku, Väisäläntie 20, 21500 Piikkiö, Finland.

The discovery of high-energy gamma-ray emission from the distant blazar PKS 1502+106 by the Large Area Telescope (LAT) onboard the Fermi Gamma-ray Space Telescope is reported. First result on these Fermi LAT observations are presented in conjunction with X-ray observations by Swift and radio-optical data by ground based observatories obtained during a simultaneous multifrequency campaign.

The activity of the blazar OJ 287 XMM-Newton observations and the corresponding wide multifrequency campaign

S. Ciprini, [1,2] *C.M. Raiteri, N. Rizzi, I. Agudo, L. Foschini, M. Fiorucci, L.O. Takalo, M. Villata, L. Ostorero, A. Sillanpää, M. Valtonen, G. Tosti, S.J. Wagner, H. Aller, M.F. Aller, A. Arai, A.A. Arkharov, U. Bach, V. Bakis, M. Bagaglia, M. Bottcher, C. Buemi, D. Carosati, W.P. Chen, Y. Efimov, D. Emmanoulopoulos, A. Erdem, L. Fuhrmann, A. Frasca, M. Fullhart, A. Goyal, J. Heidt, T. Hovatta, F. Hroch, M.A. Ibrahimov, L. Jilková, M. Joshi, M. Kamada, M. Katsuura, D. Kinoshita, A. Kostov, D. Kotaka, Y.Y. Kovalev, T. Krejčová, T. Krichbaum, G. Krishna, M. Kurosaki, O. Kurtanidze, A. Lähteenmäki, L. Lanteri, V. Larionov, C.-U. Lee, P. Leto, J. Li, E. Lindfors, F. Münz, E. Marilli, Y. Matsubara, S. Mizoguchi, S. Mondal, K. Nakamura, E. Nieppola, K. Nilsson, S. Nishiyama, G. Nucciarelli, A. Ogino, J. Ohlert, A. Oksanen, E. Ovcharov, S. Pak, M. Pasanen, C. Pullen, T. Pursimo, J.A. Ros, K. Sadakane, A.C. Sadun, R. Sagar, B.-W. Sohn, N. Sumitomo, K. Tanaka, C. Trigilio, I. Torniainen, M. Tornikoski, G. Umana, H. Ungerechts, E. Valtaoja, A. Volvach, J.R. Webb, J. Wu, H.-S. Yim, Y. Zhang*

[1]Physics Dept., University of Perugia, & INFN Perugia, via Pascoli, 06123 Perugia, Italy.
[2]Tuorla Observatory,University of Turku, Väisäläntie 20, 21500 Piikkiö, Finland.

XMM-Newton pointings of the blazar OJ 287 are presented along with part of the radio, mm, near-IR, and optical data obtained during a coordinated and intensive WEBT campaign, during longer-term monitoring observations, and during other independent observing programs (like VLBA observations). The XMM-Newton X-ray observations were performed in correspondence with two active optical states (an intermediate flare and such outburst). X-ray data indicates different flux levels, spectral slopes, and emission components, and VLBA radio maps are consistent with a jet precession model.

Finding Goodies in the COSMOS survey

F. Civano[1], *M. Elvis*[1], *G. Lanzuisi*[2] *and the Chandra COSMOS team*

[1]CfA, 60 Garden st. Cambridge, MA, USA
[2]Universita' di Roma, La Sapienza, Roma, Italy

The C-COSMOS survey is a 1.8 Ms Chandra program to image the center of the COSMOS field to a depth of 2e-16 cgs (0.5-7 keV). Adding the Chandra coverage to the COSMOS survey allows us to address several of the issues concerning the co-evolution of SMBH and their host galaxies and to fully characterize the SED of faint AGNs and starburst galaxies.

I will give a brief introduction on the survey and then I will present interesting sources we have found in the field.

In particular I will focus on the only clear double nucleus (z=0.359) host out of the 3000 X-ray sources in the COSMOS survey, and the only one to have an unprecedented 200 eV EW absorption feature that is most likely broad, highly REDshifted, iron line.

That these two unique features occur in the same source is unlikely to be a co-incidence.

This z=0.359 merger may broadening our view on the AGN-mergers connection, and on AGN feedback onto host galaxies.

The XBS AGN sample as a tool to study the spectral properties of the different kind of AGN

A. Corral, R. Della Ceca, A. Caccianiga, P. Severgnini, E. Marchese

Osservatorio Astronomico di Brera (OAB-INAF), Milano, Italy

We discuss here the results of a detailed X-ray spectral analysis of the AGN within the XMM-Newton Bright Survey (XBS), one of the largest best-defined samples of X-rays selected sources built to date. The reliability of both optical and X-ray good quality spectral data allows not only to accurately measure spectral properties, but also to unveil the AGN nature in many objects that would remain hidden otherwise. Making use of the good quality X-ray data and the high level of optical spectroscopic identification, we have been able to compute the main statistical properties of AGN as well as to carry out a detailed spectral analysis of individual sources that show remarkable spectral properties. Furthermore, by combining the spectral data, we discuss the average spectrum for the different AGN types.

Exploring the realm of an AGN: XMM-Newton and Chandra observations of Mrk279

E. Costantini[1], *J. Kaastra*[1], *K. Korista*[2], *G. Kriss*[3], *N. Arav*[4], *J. Ebrero Carrero*[1]

[1]SRON, Sorbonnelaan 2, 3584CA, The Netherlands
[2]Western Michigan University, Kalamazoo, MI 49008, USA
[3]Space Telescope Science Institute, St. Martin Drive, Baltimore, MD 21218, USA
[4]Virginia Tech, Blacksburg, Va 24061, USA

The X-ray emission and absorption spectrum of an AGN carry the signature of different regions of the black hole environment. Here we present a deep analysis of long XMM-*Newton* and *Chandra* observations of Mrk279. The spectrum displays absorption by ionized gas and a variety of emission lines. We investigate in particular the broad emission structure around OVII, OVIII and the iron Kα line. Using simultaneous HST and FUSE line-measurements, we successfully explain the oxygen features as arising from the Broad Line Region. For the first time we also quantified, by mean of a physical model, the modest contribution of the BLR to the iron Kα line, which shows a complex structure in the XMM-Newton spectrum.

Multiwavelength observations of the powerful gamma-ray blazar PKS 1510-089

F. D'Ammando [1,2], *S. Vercellone* [3], *I. Donnarumma* [1], *A. Bulgarelli* [4], *A. W. Chen* [5,6], *A. Giuliani* [5], *F. Longo* [7], *L. Pacciani* [1], *G. Pucella* [1], *M. Tavani* [1,2], *V. Vittorini* [1,6] *on behalf of the AGILE Team*

[1]INAF – IASF Roma, Via Fosso del Cavaliere 100, 00133 Roma, Italy
[2]Dip. di Fisica, Università "Tor Vergata", Via della Ricerca Scientifica 1, 00133 Roma, Italy
[3]INAF – IASF Palermo, Via Ugo La Malfa 153, 90146 Palermo, Italy
[4]INAF – IASF Bologna, Via Gobetti 101, 40129 Bologna, Italy
[5]INAF – IASF Milano, Via E. Bassini 15, 20133 Milano, Italy
[6]CIFS - Torino, Viale Settimio Severo 3, 10133 Torino, Italy
[7]Dip. di Fisica and INFN, Via Valerio 2, 34127 Trieste, Italy

PKS 1510-089 is a radio-loud highly polarized quasar at redshift z = 0.361 belonging to the class of the Flat Spectrum Radio Quasar (FSRQ), with radiative output dominated by the gamma-ray component and high variability over all the electromagnetic spectrum. In particular, in the last two years very high gamma-ray activity was detected by the Gamma-Ray Imaging Detector (GRID) on board the AGILE satellite with a flaring episode in August 2007 and March 2008. Moreover, an extraordinary activity observed during March 2009, with several flaring episodes and a flux that has reached 5×10^{-6} photons cm^{-2} s^{-1}. Multiwavelength observations in the optical and UV bands seems to indicate the presence of Seyfert-like features in the broad band spectrum of PKS 1510-089, such as the little and big blue bumps. Moreover, X-ray observations show the possible presence below 2 keV of a soft X-ray excess, whose origin is still an open issue, but that could be a feature of the bulk Comptonization.

We present both the results of the analysis of the multiwavelength data of PKS 1510-089 collected by GASP-WEBT, REM, Swift and AGILE during these gamma-ray flares and those obtained during the long term monitoring over the entire electromagnetic spectrum, as well as the theoretical implication for the emission mechanisms.

Variable Fe K features in bright radio-quiet AGNs of the FERO sample

B. De Marco[(1)], *K. Iwasawa*[(2)], *M. Cappi*[(3)], *M. Dadina*[(3)], *F. Tombesi*[(3,4,5,6)], *G. Ponti*[(7)], *A. Celotti*[(1)], *G. Miniutti*[(8)]

[(1)]International School for Advanced Studies (SISSA), Via Beirut 2-4, I-34014 Trieste, Italy
[(2)]INAF-Osservatorio Astronomico di Bologna, Via Ranzani 1, I-40127 Bologna, Italy
[(3)]INAF-IASF Bologna, Via Gobetti 101, I-40129 Bologna, Italy
[(4)]Dipartimento di Astronomia, Università degli Studi di Bologna, Via Ranzani 1, I-40127 Bologna, Italy
[(5)]Department of Physics and Astronomy, Johns Hopkins University, 3400, Baltimore, MD 21218, USA
[(6)]Laboratory for High Energy Astrophysics, NASA/Goddard Space Flight Center, Greenbelt, MD 20771, USA
[(7)]APC Université Paris 7 Denis Diderot, 75205, Paris, France
[(8)]LAEX, Centro de Astrobiologia (CSIC--INTA); LAEFF, P.O: Box 78, E-28691, Villanueva de la Canada, Madrid, Spain

Fe K line complex variability studies are of the utmost importance in order to understand the dynamics and geometry of the innermost accretion flow in AGNs. The sensitivity of current X-ray telescopes allows for the first time to address this issue with unprecedented accuracy. We present the systematic variability study of a flux-limited sample (extracted from the complete FERO sample of Guainazzi et al. 2006) which includes 30 sources for a total of 72 observations of radio quiet AGNs, observed with XMM-Newton. The focus of this project is to search for variable Fe K features. The main goal is to attempt to draw conclusions about their statistical significance, detection frequency and possible origin. The adopted analysis technique consists in tracing the features temporal behaviour by mapping excess residuals above and below the continuum emission in the time-energy domain, between 4-9 keV. The variability significance of the features is assessed through Monte Carlo simulations. We found significant excess variability in 26 out of 72 observations. The statistical robustness of this result is carefully checked and assessed at >3 sigma confidence level. Physical interpretations will be extensively discussed.

X-ray narrow line region variability as a geometry probe: A study of Seyfert 1 galaxies

R.G. Detmers[1], *J.S. Kaastra*[1,2], *I.M.H. McHardy*[3]

[1]SRON Netherlands Institute for Space Research, Sorbonnelaan 2, Utrecht, Netherlands
[2]Astronomical Institute, University of Utrecht, Postbus 80000, Utrecht, Netherlands
[3]School of Physics and Astronomy, University of Southampton, Southampton SO17 1BJ, UK

We study the long time scale variability of the gas responsible for the narrow emission lines in Seyfert 1 galaxies, in order to constrain the location and geometry of the emitting gas. By combining multiple epoch high-resolution X-ray data of NGC 5548 taken with Chandra LETGS / HETGS and XMM Newton RGS with long term monitoring data from RXTE, we determine the time scales on which the narrow line emitting gas responds to variations of the continuum flux.

Along with other observed parameters of the narrow lines (width, line ratios), this variability study allows us to put constraints on the geometry and location of the X-Ray NLR gas. We conclude that the X-ray NLR, is in the form of an ionization cone, compact in size, and located between 1 and 15 pc from the central source. We also extend our study to other suitable Seyfert 1 galaxies.

Polarization signatures of strong gravity by reflection from accretion discs

M. Dovciak[(1)], *R. Goosmann*[(2)], *V. Karas*[(1)], *G. Matt*[(3)], *F. Muleri*[(4,5)], *J. Svoboda*[(1,6)]

[(1)]Astronomical Institute, Academy of Sciences of the Czech Republic, Bocni II 1401a, CZ-141 31, Prague, Czech Republic
[(2)]Observatoire Astronomique de Strasbourg, 11 rue de l'Universite, F-67000, Strasbourg, France
[(3)]Dipartimento di Fisica, Universita degli Studi "Roma Tre", Via della Vasca Navale 84, I-00146, Rome, Italy
[(4)]Istituto di Astrofisica Spaziale e Fisica Cosmica, Via del Fosso del Cavaliere 100, I-00133, Rome, Italy
[(5)]Dipartimento di Fisica, Universita di Roma Tor Vergata, Via della Ricerca Scientifica 1, I-00133, Rome, Italy
[(6)]Astronomical Institute of the Charles University, Faculty of Mathematics and Physics, Charles University, V Holesovickach 2, CZ-18200, Prague, Czech Republic

The effects of strong gravity on the polarization of the Compton reflection from an X-ray illuminated accretion disc are studied. The gravitational field of a rotating black hole influences Stokes parameters of the radiation along the propagation to a distant observer. Assuming powerlaw illumination of the disc by corona, the degree and the angle of polarization are examined as functions of the black hole spin and observer's inclination angle. It is shown that polarimetry can provide essential information on the properties of black holes sources, and it is argued that time variation of the polarization angle is a strong signature of general relativity effects.

On the Blazar Contribution to the Cosmic X-ray Background: Implications for the Compton Thick Population

A.R. Draper, D.R. Ballantyne

Center for Relativistic Astrophysics, School of Physics, Georgia Institute of Technology, 837 State St., Atlanta, GA, USA

We investigate the contribution of blazars to the cosmic x-ray background (CXRB). By beaming the luminosity function of radio loud active galactic nuclei (AGN) we find the jet-dominated blazar luminosity function. Using empirically based average blazar spectral energy distributions we compute the blazar x-ray spectrum. We use the blazar contribution to the CXRB to constrain the population of the elusive Compton Thick class of AGN.

Probing the variability of the warm absorber in Mrk 279

J. Ebrero[(1)], *E. Costantini*[(1)], *J.S. Kaastra*[(1)], *R.G. Detmers*[(1)], *N. Arav*[(2)], *G.A. Kriss*[(3)]

[(1)]SRON - Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA, Utrecht, The Netherlands
[(2)]Department of Physics, Virginia Tech, Blacksburg, VA 24061, USA
[(3)]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA

We present here the results on the detailed modeling of the complex absorption spectrum of the Seyfert 1 galaxy Mrk 279. The source was observed three times by XMM-Newton RGS for a total exposure time of ~150 ks spread over three satellite orbits. The data are modeled in terms of two warm absorber components with different ionization parameters and blue-shifted with respect to the rest frame of the source. We find no significant response of the absorbing gas to the smooth (~25%) continuum variation of the source during the observations. We also investigate possible long term (~2 years) variations of the absorber, therefore putting important constraints on the distance of the absorber to the ionizing source as well as studying the possible relationships between the spectral components on long term timescales.

Spatially Resolved Chandra HETG Spectroscopy of the NLR Ionization Cone in NGC 1068

D.A. Evans [(1)], *P.M. Ogle* [(2)], *H.L. Marshall* [(1)], *M.A. Nowak* [(1)], *A.L. Longinotti* [(1)], *C.R. Canizares* [(1)]

[(1)]MIT Kavli Institute Institute for Astrophysics and Space Research, 77 Massachusetts Ave., NE80, Cambridge, MA 02139, USA
[(2)]California Institute of Technology, Pasadena, CA 91125, USA

We present preliminary results from a new 440-ks Chandra HETG GTO observation of the canonical Seyfert 2 galaxy NGC 1068. The proximity of NGC 1068, together with Chandra's superb spatial and spectral resolution, allow an unprecedented view of the nucleus and circumnuclear NLR in an AGN. We perform the first spatially resolved high-resolution spectroscopy of the “ionization cone” in NGC 1068, and use the sensitive line diagnostics offered by the HETG to measure the ionization state, density, and temperature at discrete points along the ionized NLR. We argue that the NLR takes the form of outflowing photoionized gas, rather than gas that has been collisionally ionized by the small-scale radio jet in NGC 1068. We investigate evidence for any velocity gradients in the outflow, and describe our next steps in modeling the NLR as a multiphase biconical outflow. Our results have key implications for the nature of the nuclei and circumnuclear environments in AGN, together with the connection between accretion and outflows in active galaxies.

Unveiling a New Population of Variable X-ray Sources Using the 2XMM Catalogue

S. Farrell[1], *N. Webb*[2], *D. Barret*[2], *A. Gosling*[3], *D. Villa-Pascual*[2], *J. Rodrigues*[2]

[1]University of Leicester, University Road, Leicester, LE1 7RH, UK
[2]CESR, 9 Avenue du Colonel Roche, Toulouse, 31028, France
[3]University of Oxford, Keble Road, Oxford, OX1 3RH, UK

The Second XMM-Newton Serendipitous Source Catalogue (2XMM) is the largest X-ray source catalogue ever produced, containing 221,012 discrete sources. The latest incremental version of the catalogue contains 2,267 unique variable sources, ~20% of which have not been previously identified. We have examined the images, light curves and spectra of these variable sources and performed a search of the literature in an attempt to identify their nature. Using these identifications we have performed population studies of the major source categories – X-ray emitting stars, active galactic nuclei, X-ray binaries and cataclysmic variables. I will present the results of these studies, and will show how these results allow for the identification and sub-classification of new sources based on the spectral hardness information contained in the catalogue. These studies show clear delineation between neutron star and black hole X-ray binaries in the X-ray colour-colour diagrams, which indicates that as many as four globular clusters in the galaxy M31 may contain black holes.

Hard X-ray to γ-ray spectrum of NGC 4388: simultaneous modelling of XMM-Newton, INTEGRAL and Swift/XRT results

E.V. Fedorova[(1)] , *A. Neronov*[(2,3)], *V. Beckmann*[(2,3)], *V. Bianchin*[(4)]

[(1)]Astronomical Observatory of Kiev Taras Schevchenko University, Observatorna str. 3, Kiev, Ukraine
[(2)]ISDC data centre for Astrophysics, Chemin d'Écogia 16, 1290 Versoix, Switzerland
[(3)]Observatoire Astronomique de l'Université de Genevè, Chemin des Mailettes 51, 1290 Sauverny, Switzerland
[(4)]INAF/IASF-Bologna, Via Gobetti 101, 40129 Bologna, Italy

We have performed modelling of the broad-band X-ray to γ-ray spectrum of the Seyfert 2 galaxy NGC 4388. The high-energy spectrum (above 20 keV) is based on INTEGRAL IBIS/ISGRI observations during four years of observations; the hard X-ray spectra were obtained from two XMM-Newton/EPIC, three Swift/XRT, and INTEGRAL/JEM-X observations. These observations, performed from 2003 to 2006 enable us to obtain the total spectrum in the 3-200 keV energy range. The hard X-ray to γ-ray emission of NGC 4388 in 3-200 keV energy range is well represented by two absorbed (hydrogen column density is $(2.2\pm0.1)*10^{23}$ cm^{-2}) models: a cut-off power-law model, with the high-energy cut-off at ~ 50 keV, and a model taking into account Compton reflection, both with an Fe-Kα line near 6.4 keV. We also find a significant variability of the source in the 20-40 keV band up to ~200 day time scale. Minimal variability timescales in 20-40, 40-60 and 60-100 keV are 5 days. The spectral modelling of the two states with relatively high and low flux in 2-0-40 keV separately shows the immediate changes of the reflection component in the spectrum.

Resolved mid-infrared imaging of AGN: an isotropic measure of intrinsic power

P. Gandhi[(1)], *H. Horst*[(2)], *A. Smette*[(3)], *S.F. Hönig*[(4)], *A. Comastri*[(5)], *R. Gilli*[(5)], *C. Vignali*[(6)], *W.J. Duschl*[(2)]

[(1)]RIKEN Cosmic Radiation Laboratory, 2-1 Hirosawa, Wako, Saitama 351-0198 Japan
[(2)]Institut für Theoretische Physik und Astrophysik, Christian-Albrechts-Universität zu Kiel, Leibnizstr. 15, 24098 Kiel, Germany
[(3)]European Southern Observatory, Alonso de Cordova 3107, Casilla 19001, Santiago, Chile
[(4)]Max-Planck-Institut für Radioastronomie, Auf dem Hügel 69, 53121 Bonn, Germany
[(5)]Istituto Nazionale di Astrofisica (INAF) - Osservatorio Astronomico di Bologna, via Ranzani 1, 40127 Bologna, Italy
[(6)]Dipartimento di Astronomia, Università degli Studi di Bologna, Via Ranzani 1, I-40127 Bologna, Italy

We present new results suggesting that resolved mid-infrared (mid-IR) imaging of active galactic nuclei (AGN) is an isotropic probe of their intrinsic luminosities. We have obtained the largest sample to date of 8-m telescope diffraction-limited mid-IR imaging of radio-quiet AGN in the local Universe (42 sources so far), using which we find a strong correlation between mid-IR (12 micron) and intrinsic X-ray (2-10 keV) luminosities. The relation holds true for Seyferts of all types, including unobscured, obscured, as well as heavily Compton-thick sources. Thus, the mid-IR directly probes the intrinsic accretion power irrespective of obscuration, and provides a new and accurate proxy of AGN luminosity (complementing other tools such as the forbidden [OIII]5007 emission line). The relation may also be extended smoothly to the higher luminosity quasar regime. At the high angular resolution of our data (<0.4 arcsec), most star formation around the nuclei is resolved out; the remaining unresolved mid-IR flux is dominated by the AGN alone. This enables clean estimates of bolometric luminosities to be derived for the first time. The dispersion in the mid-IR:X-ray relation is tight enough to provide sensitive discrimination between physical models of clumpy vs. smooth dusty tori geometries, and will help to constrain any underlying non-thermal radiation components. Finally, our relation also provides a new pathway for estimating the intrinsic powers of Compton-thick AGN.

Study of microwave/gamma-ray properties for Fermi-LAT bright AGNs

D. Gasparrini [(1)(2)], *E. Cavazzuti* [(1)(3)], *P. Giommi* [(1)(3)], *C. Pittori* [(1)(4)], *S. Colafrancesco* [(1)(3)] *for the Fermi LAT collaboration*

[(1)]Agenzia Spaziale Italiana (ASI) Science Data Center, I-00044 Frascati (Roma), Italy
[(2)]Consorzio Interuniversitario per la Fisica Spaziale (CIFS), I-10133 Torino, Italy
[(3)]Agenzia Spaziale Italiana (ASI), I-00198 Roma, Italy
[(4)]INAF- Osservatorio Astronomico di Roma, I-00040, Monteporzio Catone (Roma), Italy

The Large Area Telescope (LAT), the main instrument on-board the Fermi Gamma-ray Space Telescope (formerly GLAST) is a pair conversion detector designed to study the gamma-ray sky in the energy range from 20 MeV to > 300 GeV. During the first 3 month of scientific operations Fermi detected 106 bright, high-galactic latitude (|b|> 10 deg) AGNs with high significance. In this study we investigate the possible relations between the microwave and the gamma-ray emissions for a blazar sample defined cross-correlating the Fermi-LAT bright AGNs list and the WMAP 5th year bright source catalog.

The AGN 5-10 keV X-ray luminosity function and its evolution

I. Georgantopoulos, *S. Fotopoulou, A. Akylas , A. Georgakakis*

Institute of Astronomy & Astrophysics, National Observatory of Athens

We present an analysis of the X-ray luminosity function in the ultra-hard 5-10 kev band. This is performed using both bright XMM data (XMS, HBSS) as well as deep Chandra data (CDFs, AEGIS. Our sample consists of 795 sources (of which 650 have either a spectroscopic or a photometric available) reaching redshifts up to z~4. The luminosity function in this hard band provides the most uninhibited view of the X-ray Universe as it is hardly affected by obscuration. We find that a Luminosity Dependent Density Evolution model provides the best fit to the data. The derived evolution is very strong in agreement with previous XMM results at lower redshifts.

A deep look at the inner regions of the mini-BAL QSO PG 1126-041 with XMM-Newton

M. Giustini[1,2,3], *M. Cappi* [3], *G. Chartas*[1], *M. Eracleous*[1], *G.G.C. Palumbo*[2], *C. Vignali*[2,4]

[1]Department of Astronomy & Astrophysics, Pennsylvania State University, 525 Davey Lab, University Park, PA 16802, USA
[2]Dipartimento di Astronomia, Università degli Studi di Bologna, via Ranzani 1, 40127 Bologna, Italy
[3]INAF/Istituto di Astrofisica Spaziale e Fisica Cosmica di Bologna, via Gobetti 101, 40129 Bologna, Italy
[4]INAF/Osservatorio Astronomico di Bologna, via Ranzani 1, 40127 Bologna, Italy

Quasar outflows provide a promising feedback mechanism between supermassive black holes and their environments. X-ray observations are crucial in both quantifying the total mass outflow rate and in providing insight into the acceleration mechanism of the outflows.

The low redshift (z=0.06) mini-broad absorption line quasar PG 1126-041 hosts ultraviolet absorbing gas outflowing at a few 10^3 km s^{-1}. Its X-ray properties are rather complex.

Our spectral and timing analysis of four XMM-Newton observations of PG 1126-041 show 0.2-10 keV spectral variability over different time-scales (both hours and months) and imply high ($N_H \sim 10^{22-23}$ cm^{-2}) column densities of ionized gas (log $\xi \sim 1.5$-2.5 erg cm s^{-1}) along the line of sight.

We investigate the variability of the ionizing X-ray source and absorber of PG 1126-041 and compare the X-ray and UV absorbing properties to improve our understanding of the physical mechanism responsible for the quasar outflow and to obtain an estimate of the efficiency of the outflow.

Thermal Instabilities in the Wind of NGC 3783

R.W. Goosmann[(1)], *E. Behar*[(2)], *O.Godet*[(3)], *A. Goncalves*[(4)], *T. Holczer*[(2)], *S. Kaspi*[(2)], *M. Mouchet*[(5)]

[(1)]Observatoire Astronomique de Strasbourg, Strasbourg, France
[(2)]Technion, Haifa, Israel
[(3)]Centre d'Etude Spatiale des Rayonnements, Toulouse, France
[(4)]Observatoire de Paris, Meudon, France
[(5)]Laboratoire Astroparticule et Cosmologie, Paris, France

Outflows in Active Galactic Nuclei (AGN) play an important role for galaxy evolution and the enrichment of the intergalactic medium. In the X-ray range they appear as warm absorbers (WA). Thanks to the recently introduced Absorption Measure Distribution (AMD) method, the column densities of individual ionic species of the wind can be derived from observed X-ray spectra, which gives a new handle on constraining the physics of the WA. We report the theoretical interpretation of an AMD analysis for the Seyfert galaxy NGC 3783. The AMD results based on the known 900-ksec Chandra observation suggest that the WA is in pressure equilibrium as was indicated before by spectral analysis. Conducting radiative transfer simulations for such a case we reproduce the measured ionic column-densities by adjusting several crucial parameters of the medium: the ionization parameter, the total column density and element abundances, and the amount of micro-turbulence. We use the code TITAN that is particularly adequate to the radiative transfer in X-ray photoionized gases at constant total pressure. The WA plasma is probably a clumpy, two-phase medium where cold, dense clumps are embedded in a hotter, diffuse gas. We compute the temperature solutions for the net cooling of the hot and cold gas phases. The knowledge of these individual solutions helps to constrain the physical state of the WA medium more precisely.

Modeling the X-ray variability of AGN: multiple flaring of accretion disk coronae

R.W. Goosmann[(1)], *M. Mouchet*[(2)], *B. Czerny*[(3)], *M. Dovciak*[(4)], *V. Karas*[(4)], *A. Goncalves*[(5)]

[(1)]Observatoire Astronomique de Strasbourg, Strasbourg, France
[(2)]Laboratoire Astroparticule et Cosmologie, Paris, France
[(3)]Nicolaus Copernicus Astronomical Center, Warsaw, Poland
[(4)]Astronomical Institute, Prague, Czech Republic
[(5)]Observatoire de Paris, Meudon, France

Explaining the X-ray spectrum of radio-quiet AGN requires the presence of a two-phase medium close to the supermassive black hole. The colder phase is identified with the innermost parts of the accretion disk; a possible interpretation of the hot phase is to assume a disk corona that is heated by multiple X-ray flares. The randomness of the flares can explain the rapid X-ray variability and their irradiation of the disk gives rise to the observed X-ray reprocessing. The flare emission eventually causes the disk medium to expand accelerating local winds and modifying the reprocessed spectrum. We show how X-ray spectra, rms variability, and power density spectra of AGN can be interpreted by a multiple flare model. Our model has been extended with respect to its earlier version and now includes a detailed spectral evolution of the individual flares. We apply our method to a 300 ksec XMM-Newton observation of the Seyfert galaxy MCG-6-30-15.

Structure of the magnetoionic media around the FR Class I radio galaxy 3C449

D. Guidetti[1,2], R. Laing[1], M. Murgia[2,3], F. Govoni[3], L.Gregorini[4], P. Parma[2], L. Feretti[2]

[1]ESO, Karl-Schwarzschild-Str. 2, Garching bei Muenchen, 85748, Germany
[2]INAF-Istituto di Radioastronomia, via Gobetti 101, 40129, Bologna, Italy
[3]INAF-Osservatorio Astronomico di Cagliari, Loc. Poggio dei Pini, Strada 54, 09012, Capoterra (Italy)
[4]Astronomy Department, Univ. Bologna, via Ranzani 1, 40127, Bologna (Italy)

Magnetic fields in the hot plasma associated with groups and clusters of galaxies are poorly understood, but are thought to play a vital role in the regulating thermal conduction and stabilising the cavities formed by radio jets. One of the few ways of studying these fields is via the Faraday effect: rotation of the plane of linearly polarized radiation by a magnetised plasma.

Synchrotron emission from radio sources (either behind or embedded within the group/cluster medium) can be used to probe the distribution of foreground Faraday rotation. A key aspect of our approach is the combination of accurate RM imaging with high-quality Chandra and XMM-Newton X-ray observations, which give the thermal gas density profile, to infer the strength and fluctuation properties of the magnetic field. I will present the case of the extended radio galaxy 3C449, the most prominent member of the group of galaxies 2231.2+3732.

XJET: Cheap and Dirty X-ray Photometry of Extragalactic Jets

D.E. Harris[(1)], *C.C. Cheung*[(2)] *and F. Massaro*[(1)]

[(1)]SAO, 60 Garden St., Cambridge, MA, 02138, USA
[(2)]GSFC, Greenbelt, MD, USA

For several years we have been collecting basic parameters for extragalactic jets detected in the X-rays. There are now about 90 sources for which X-ray detections of knots and hotspots have been published. In 2009 we have been adding a suite of fits files for each source consisting of flux maps in 3 X-ray energy bands together with an event file which has had pixel randomization removed and also been registered so that the nuclear emission is aligned with the radio nucleus to within approximately 0.1 arcsec. We also provide the radio map used for registration. In this poster, we show how users can obtain X-ray flux values for any region in the images and give some basic statistics of the sample. The XJET website (http://hea-www.harvard.edu/XJET/) is partially supported by NASA grant AR6-7013X.

Clumpy accretion flows in Active Galactic Nuclei: X-ray variability and spectral properties

W. Ishibashi[1,2], *T.J.L. Courvoisier*[1,2]

[1]ISDC Data Centre for Astrophysics, ch. d'Ecogia 16, 1290 Versoix, Switzerland
[2]Geneva Observatory, Geneva University, ch. des Maillettes 51, 1290 Sauverny, Switzerland

We discuss the fueling of the central black hole in Active Galactic Nuclei in the framework of a clumpy accretion flow. Shocks between elements (clumps) forming the accretion flow are at the origin of the observed radiation. We expect a cascade of shocks, with optically thick shocks giving rise to optical/UV emission and optically thin shocks accounting for the X-ray emission.

We associate the characteristic X-ray variability time scale derived within our model with the break time scale observed in the X-ray Power Spectral Density (PSD). The predicted dependence of the variability time scale on black hole mass and accretion rate is in agreement with the observational relation obtained by McHardy et al. (2006).

We further discuss X-ray spectral properties, in particular we compare the predicted hard X-ray power law slope with observations. Model results are able to reproduce the range of photon index typically measured in Seyfert galaxies and may account for the observed correlation between photon index and normalized accretion rate.

The X-ray and VHE gamma-ray connection of BL Lac objects

S. Kaufmann, *S. Wagner*

Landessternwarte, ZAH, Universität Heidelberg, Königstuhl 12, D-69117 Heidelberg, Germany

The spectral energy distribution of BL Lac objects can be explained by synchrotron emission which peaks in the UV - X-ray regime and inverse Compton emission from a population of relativistic electrons which upscatter their own synchrotron photons into the Gev - TeV regime. Simultaneous observations in the X-ray and gamma-ray bands can hence be used to quantify physical parameters of the emitting regions.

From those it is possible to shed light on the processes of particle acceleration in the jets of active galactic nuclei.

We present simultaneous X-ray and TeV observations to determine the synchrotron peak and spectral slope up to the peak during the recording of TeV spectra.

The X-ray and Optical Properties of the Swift BAT-detected AGN

M. Koss[1,2], *R. Mushotzky*[1], *C. Reynolds*[2], *S. Veilleux*[2], *L. Winter* [3]

[1]NASA GSFC, Greenbelt, MD, USA
[2]University of Maryland, College Park, MD, USA
[3]CASA/University of Colorado, Boulder, CO, USA

Surveys of AGN taken in the optical, UV, and soft X-rays miss an important population of obscured AGN only visible in the hard X-rays and mid-IR wavelengths. The SWIFT BAT survey in the hard X-ray range (14-195 keV) has provided a uniquely unbiased sample of 258 AGN unaffected by galactic or circumnuclear absorption. Optical imaging of this unbiased sample provides a new opportunity to understand how the environments of the host galaxies are linked to AGN. In 2008, we observed 110 of these targets at Kitt Peak with the 2.1m in the SDSS bands over 17 nights. Using these observations and SDSS data we review the relationships between color, morphology, merger activity, star formation, and AGN luminosity.

The Clustering of broad-line AGNs in the ROSAT All-Sky Survey through Cross-correlation with Luminous Red Galaxies

M. Krumpe[(1)], *T. Miyaji*[(2)], *A. Coil*[(1)]

[(1)]University of California, San Diego, Center for Astrophysics & Space Sciences, 9500 Gilman Drive, La Jolla, CA 92093, USA
[(2)]IAUNAM-E (Instituto de Astronomía de la Universidad Nacional Autonoma de Mexico, Ensenada), PO Box 439027, San Diego, CA, 92143-9027, USA

We present the first analysis of the spatial cross-correlation function (CCF) of X-ray selected broad-line AGN from the ROSAT All Sky Survey (RASS) and SDSS Luminous Red Galaxies (LRGs) at z~0.3. By measuring the CCF of the AGN with a large number of galaxies, we are able to obtain the bias parameter of the AGN with respect to dark matter with a much better statistical accuracy than using the auto-correlation function (ACF) of AGN alone. This allows us to measure the typical mass of the dark matter halo in which they reside and also infer the host galaxy type of the X-ray AGN. We use ~1,300 broad-line AGN with log(Lx)<= 44.5 and 0.16<z<0.36 from Anderson et al. 2007's catalog of SDSS optical AGN matching RASS sources. As a tracer of large-scale structure, we use a sample of ~45,000 LRGs from SDSS in the same redshift range which have well-defined selection criteria and a well-measured auto-correlation function. Our preliminary result of a power-law fit to the projected w_p(r_p) implies a comoving clustering scale length of r_0 ~ 6 h^{-1} Mpc for the CCF, while the ACF of LRGs themselves as measured by Zehavi et al. 2005 is r_0 ~ 10 h^{-1} Mpc. Consequently, broad line X-ray AGN in the chosen redshift/luminosity range have a relatively low clustering scale length of r_0 ~ 4 h^{-1} Mpc, in contrast to larger values at z~1 reported in the literature from deep surveys.

A local sample for high redshift QSOs: The X-ray spectra of the most X-ray luminous radio-quiet ROSAT Bright Survey QSOs

M. Krumpe[1], *G. Lamer*[2], *A. Corral*[3]

[1]University of Califonria, San Diego, Center for Astrophysics & Space Sciences, 9500 Gilman Drive, La Jolla, CA 92093, USA
[2]Astrophysikalisches Institut Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany
[3]INAF - Osservatorio Astronomico di Brera, via Brera 28, 20121 Milan, Italy

We present the analysis of XMM-Newton X-ray spectra of the 4 most X-ray luminous radio-quiet QSOs found in the ROSAT Bright Survey. A homogeneous sample was chosen by selecting radio-quiet QSO with luminosities log L_X >= 45.

We discuss if the four studied objects show homogeneous properties in their X-ray spectra. Furthermore, we investigate the existence and strength of an Fe K-alpha line and the complexity of the X-ray spectra. The sample is considered to serve as a local reference for the interpretation of the usually low signal-to-noise ratio spectra of QSOs with similar luminosities found at higher redshifts. Our results show that all X-ray spectra can only be satisfyingly modeled with multi-component spectral models. All objects show evidence for soft excess and a weak and narrow Fe K-alpha line. Self-consistent disk reflection models do not significantly improve the fit of the X-ray spectra. We will discuss the determined equivalent width of the Fe K-alpha line in our objects in the context of the X-ray Baldwin effect.

Giant high-redshifted radio galaxies as probes of most distant visible radio sources and the IGM evolution

E. Kuligowska

Astronomical Observatory of Jagiellonian University, Cracow, Poland

A first attempt to find possible examples of high redshifted radio galaxies with linear sizes about 1 Mpc ("giant radio galaxies") had been made and a probe of about 40 candidates for very distant radio sources had been examined. Most distant giant radio galaxies are interesting both because of their cosmological meaning (ex. studying the density and inhomogeneity of IGM) and themselves (studying physical parameters of this kind of "unusual" galaxies.). For this purpose we use computer simulations based on analytical models of radio galaxies and theirs jet propagation through the intergalactic medium. This type of model requires at least three different radio fluxes of radio galaxy corresponding to three radio frequencies. The shape of radio spectra indicates that we extremely need one data point for low frequency. LOFAR project with surveys at 50, 100 and 200 MHz will be probably perfect for mapping selected giant radio sources from our sample at low radio frequency and so, constraining their physical parameters using numerical modeling. Also X-ray observation of this type of distant object will be necessary for better understanding their physics and origin.

The Palermo Swift-BAT survey: highlights and results

V. La Parola et al.

INAF - IASF Pa, Via U. La Malfa 153, Palermo, Italy

We present the Palermo *Swift*-BAT hard X-ray catalogue obtained from the analysis of the first 52 months of the Swift mission. The survey covers 90% of the sky down to a flux limit of ~1.0 milliCrab and 50% of the sky down to a flux limit of 0.5 milliCrab.

We obtain a list of ~1200 detections above a significance threshold of 4.8 standard deviations. Through cross correlation with low energy catalogues and analysis of follow-up XRT observations, we identify ~1000 sources, of which ~70% are extragalactic, ~20% are Galactic objects, ~10% are already known X-ray or gamma ray emitters whose nature has not been determined yet.

We present the main spectral and timing properties of selected samples of sources in the catalogue.

X-ray spectral analysis of sources in the Chandara COSMOS survey

G. Lanzuisi[1,2], *F. Civano*[1], *M. Elvis*[1], *F. Fiore*[2], *A. Fruscione*[1], *T. Aldcroft*[1]

[1]SAO CfA 60 Garden st., Cambridge, MA 02138, USA
[2]OAR V. Frascati 33, Monteporzio, (RM) 00040, Italy

We present a detailed X-ray spectral analysis of the 400 brightest sources in the Candra COSMOS catalogue (Elvis et al. 2009) that present at least 80 total net counts in the 0.5-10 keV band.

We performed the spectral fitting assuming as underling model a simple power law modified by photoelectric absorption. All the available spectroscopic or photometric redshift are used in the spectral fit.

We analyzed the statistical distribution of the X-ray spectral properties in the sample (e.g. Nh and LX distribution, fraction of obscured sources) and their correlation with multiwavelenght properties.

We also performed a simultaneous spectral fitting with the XMM-Newton data for all the sources in common, in order to check for variability in flux and obscuration, and systematic differences in the constraint on spectral parameters.

Optical and X-ray spectroscopy of faint AGN in the 13H XMM-Newton Deep Field

N. S. Loaring[1] *, M. J. Page*[2]*, T. Dwelly*[3]*, I. McHardy*[3]*, N. Seymour*[2]

[1]SAAO/SALT, P.O. Box 9, Observatory, Cape Town, 7935, South Africa.
[2]MSSL, University College London, Dorking, Surrey, RH5 6NT, UK.
[3]School of Physics and Astronomy, University of Southampton, SO17 1BJ, UK.

We present the results of a comparison of the optical and X-ray spectral properties of a sample of faint X-ray selected AGN. The sample was obtained from a XMM-Newton/Chandra survey of the ROSAT 13H Deep Field (Loaring et. al. 2005), a well studied survey area with optical, NIR, IR (Spitzer) and radio follow-up. This study focuses on >50 spectroscopically confirmed AGN/NELGs with good quality X-ray spectra (Page et. al. 2006). We investigate the optical extinction due to dust and X-ray obscuration by cold gas in these objects in order to probe their dust properties and dust-to-gas ratios.

FERO (Finding Extreme Relativistic Objects):
the XMM-Newton view of the relativistic Iron K alpha line in type 1 Active Galaxies

A.L. Longinotti[(1)] *, I. de la Calle, M. Guainazzi, S. Bianchi, M. Dovciak*

[(1)]MIT Kavli Institute for Astrophysics and Space Research, 77 Massachusetts Avenue, NE80-6011 Cambridge, MA 02139 - USA

Observing an asymmetric profile of the fluorescence Fe K alpha line in X-ray spectra of accreting compact objects is explained as a signature of relativistic effects produced by the gravitational field of the central mass on the X-ray photons emitted in its vicinity. While the theory behind the relativistic Fe line lays on solid grounds, the observational evidence for relativistically broadened Iron lines for both stellar and supermassive black holes is still at the centre of controversial debate.
To address this topic, the FERO project makes use of the largest sample of X-ray spectra of radio quiet Type 1 AGN available in the XMM-Newton archive. We perform a systematic fit of the individual sources using the full relativistic code developed by Dovciak et al. (2004) under the assumption that the relativistic model is an appropriate description of the X-ray data. The main results are: relativistic effect are detected at a significant level in 30-40% of the sources; there is no evident correlation with black hole mass and Eddington ratio; there is a tentative anti-correlation of Fe line intensity and hard X-ray Luminosity, which might be due to selection effect (i.e. lack of sources at high X-ray Luminosity); the analysis of the stacked residuals performed on the faintest sources indicates that the broad Fe line is weaker (i.e. less than 150 eV) than found in previous works.

A panchromatic view of the evolution of Supermassive Black Holes

E. Lusso[(1)], *A. Comastri*[(2)], *C. Vignali*[(1,2)], *G. Zamorani*[(2)], *M. Brusa*[(3)], *R. Gilli*[(2)], *K. Iwasawa*[(2)], *M. Salvato*[(4)], *F. Civano*[(5)], *M. Elvis*[(5)]

[(1)]INAF-OABO,via Ranzani 1,Bologna, Italy
[(2)]INAF-Osservatorio Astronomico di Bologna, via Ranzani 1, I-40127 Bologna, Italy.
[(3)]Max Planck Institut fuer extraterrestische Physik, Giessenbachstrasse 1,85748 Garching, Germany.
[(4)]California Institute of Technology, MC 105-24, 1200 East California Boulevard, Pasadena, CA 91125, USA.
[(5)]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street,Cambridge, MA 02138, USA.

We present the preliminary results of a systematic study of the spectral energy distributions (SEDs) of a statistically meaningful sample of about 300 Type 2 AGNs from XMM-COSMOS survey. Obscured AGN SED are contaminated by host galaxy stellar light. Making use of the multiwavelength database and the morphological information of the COSMOS database we were able to estimate the nuclear emission and compute nuclear SED for a wide range of redshifts and luminosities.

A reliable estimate of the SED is of fundamental importance for the calculation of the bolometric luminosities and therefore for the study of the physical processes of accretion onto SMBH and for their evolution in the cosmic time.

X-ray selected Type-2 QSOs: a laboratory to study ongoing star formation and black hole accretion

V. Mainieri and COSMOS collaboration

ESO, Karl-Schwarzschild-Strasse 2, D-85748 Garching bei Muenchen, Germany

We present a large sample (121 objects) of X-ray selected Type-2 QSOs from the XMM-COSMOS survey: sources with high X-ray luminosity ($L_X>10^{44}$ erg s^{-1}) and heavy obscuration ($N_H>10^{22}cm^{-2}$), as derived from a detailed X-ray spectral analysis (see Mainieri et al., 2007, ApJS, 172, 368) of the ~1800 X-ray point-like sources in this survey. Few (~5%) of the Type-2 QSOs are best fitted with a pure reflection model. We compare the general properties of the host galaxies with the ongoing accretion in their nuclei. *Morphology*: using five non-parametric diagnostics (asymmetry, concentration, Gini coefficient, M20, ellipticity) we found that ~10% of the Type-2 QSOs are in elliptical galaxies, ~55% in disk galaxies and ~35% in irregular galaxies. The majority of the irregular hosts can be described as undergoing merger activity or show tidal debris. *Stellar masse*s have been derived from SED fitting to the observed photometry (from 0.3 to 4.5 micron) and *star formation rates* from the [OII] or Hα line fluxes. The majority (~75%) of QSO-2 host galaxies have stellar masses above log(M_{star})~10.5 M_{Sun} and have ongoing star formation (<SFR>~100 M_{Sun}/yr). The value of 10.5 M_{Sun} is similar to the characteristic mass for obscured AGN (Kauffmann et al. 2003) and radio-loud AGN (Best et al. 2005) in the SDSS. It is also consistent with the more general result that the fraction of galaxies hosting AGN increases with the stellar mass.

Galex measurements of the Big Blue Bump in AGN as a tool to study bolometric corrections

E. Marchese, R. Della Ceca, A. Caccianiga, A. Corral and P. Severgnini

Osservatorio Astronomico di Brera, Milan, Italy

Active Galactic Nuclei, powered by accretion onto a Super-massive Black Hole (SMBH), emit over the entire electromagnetic spectrum with the peak of the accretion disk emission in the far-UV, a wavelenght range historically difficult to investigate. We discuss here the GALEX Near-UV and Far-UV properties of a sample of ~200 X-ray selected AGN extracted from the XMM-Newton Bright Serendipitous Survey. These observations will be used to constrain the luminosity of the accretion disk as well as to calculate the hard X-ray bolometric correction factors for a significant sample of AGN spanning a large range in properties (z, Lx, optical spectral properties).

The Blazar content of the BAT sky

A. Maselli

INAF, Istituto di Astrofisica Spaziale e Fisica Cosmica, Palermo (Italy)

We present the results of a study on the Blazar content in the 14-150 keV map obtained with the BAT telescope on board the Swift satellite. We developed a dedicated highly efficient algorithm for data processing and image reconstruction of the BAT survey data. An all-sky map of the hard X-ray emission and its associated significance, evaluated with an angular resolution of about 1 arcmin, was derived analizing data relative to the first 39 months of the mission. We performed a cross-correlation of this significance map with the blazar population of the Roma-BZCat and found that more than 100 sources correspond to significance excesses higher than 3 standard deviations. A final sample of blazars, after corrections for source confusion and spurious detections, is obtained and its main properties are presented.

X-ray spectral analyses of the M87 jet

F. Massaro [1], *C.C. Cheung*[2], *D.E. Harris, E.S. Perlman*[3], *W. Sparks*[4], *L. Stawarz*[5]

[1]Harvard, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge, MA 02138
[2]NASA Goddard Space Flight Center, Greenbelt, MD 20771
[3]Florida Institute of Technology, 150 West University Boulevard, Melbourne, FL 32901
[4]Space Telescope Science Institute, 3700 San Martine Drive, Baltimore, MD 21218
[5]Kavli Institute for Particle Astrophysics and Cosmology, Stanford University, Stanford, CA 94305

We present X-ray spectral analyses of the jet in the giant radio galaxy M87. We derive spectral parameters of the X-ray emission between the radio knots from the various long observations in the Chandra archive. In addition we use the 60 monitoring observations (5ks each, spanning the last 7 years) to evaluate the X-ray spectral variability of the three brightest knots, HST-1, D, and A.
This project is one component of a broader investigation of the spectral energy distribution for all parts of the entire jet. The work at SAO was supported by NASA grants GO8-9116X and GO9-0108X.

The Chandra 3C Snapshot Survey for Sources with z<0.3

F. Massaro[(1)], *D.E. Harris*[(1)], *D. Axon*[(2)], *S. A. Baum*[(2)], *A. Capetti*[(3)], *M. Chiaberge*[(4,5)], *R. Gilli*[(6)], *G. Giovannini*[(5,7)], *P. Grandi*[(8)], *F. D. Macchetto*[(4)], *C. P. O'Dea*[(2)], *G. Risaliti*[(9)], *W. Sparks*[(4)]

[(1)]Harvard, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge, MA 02138
[(2)]Dept of Physics, Rochester Institute of Technology, Carlson Center for Imaging Science 76-3144, 84 Lomb Memorial Dr., Rochester, NY 14623
[(3)]INAF - Osservatorio Astronomico di Torino, Strada Osservatorio 20, I-10025 Pino Torinese, Italy
[(4)]Space Telescope Science Institute, 3700 San Martine Drive, Baltimore, MD 21218
[(5)]INAF - Istituto di Radioastronomia di Bologna, via Gobetti 101 40129 Bologna, Italy
[(6)]INAF - Osservatorio Astronomico di Bologna, Via Ranzani 1, 40127, Bologna, Italy
[(7)]Dipartimento di Astronomia, Universita' di Bologna, via Ranzani 1, 40127 Bologna, Italy
[(8)]INAF-IASF - Istituto di Astrofisica Spaziale e fisica cosmica di Bologna, Via P. Gobetti 101, 40129, Bologna, Italy
[(9)]INAF - Osservatorio Astronomico di Arcetri, Largo E. Fermi 5, 50125, Firenze, Italy

We report on our Chandra Cycle 9 program to observe half of the 60 as yet unobserved 3C radio sources at $z<0.3$ for 8 ksec each, the remainder has been proposed in Cycle 11.

Here we present the X-ray analyses of the first 30 AO-9 sources. We also compare these observations with VLA radio maps and HST data to search for extended emission corresponding to jets and hotsposts.

Finally, a comparison of X-rays flux maps in different energy ranges is presented. This allow us to study the absorption of nuclear regions and, when possible, to investigate the emission of their extended regions.

We found the X-ray counterpart in 5 hostpots, in the 3C 17 curved jet and we detected the X-ray nuclear emission from all the radio galaxies in our sample with only one exception.

We discovered the X-ray emission in 3 Compact Steep Spectrum radio galaxies and in one of these we studied the extended X-ray emission spatially associated with the optical emission line region.

The work at SAO is supported by NASA grant GO8-9114A.

Extended X-ray emission in radio galaxies: the peculiar case of 3C 305

F. Massaro[1], *M. Chiaberge*[2,3], *P. Grandi*[4], *G. Giovannini*[3,5], *C. P. O'Dea*[6], *F.D. Macchetto*[2], *S. A. Baum*[6], *R. Gilli*[7], *A. Capetti*[8], *A. Bonafede*[5], *E. Liuzzo*[5]

[1]Harvard, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge, MA 02138
[2]Space Telescope Science Institute, 3700 San Martine Drive, Baltimore, MD 21218
[3]INAF - Istituto di Radioastronomia di Bologna, via Gobetti 101 40129 Bologna, Italy
[4] NAF-IASF - Istituto di Astrofisica Spaziale e fisica cosmica di Bologna, Via P. Gobetti 101, 40129, Bologna, Italy
[5]Dipartimento di Astronomia, Universita' di Bologna, via Ranzani 1, 40127 Bologna, Italy
[6]Dept of Physics, Rochester Institute of Technology, Carlson Center for Imaging Science 76-3144, 84 Lomb Memorial Dr., Rochester, NY 14623
[7]INAF - Osservatorio Astronomico di Bologna, Via Ranzani 1, 40127, Bologna, Italy
[8]INAF - Osservatorio Astronomico di Torino, Strada Osservatorio 20, I-10025 Pino Torinese, Italy

Extended X-ray structures are common in Active Galactic Nuclei (AGNs).

Here we present the first case of a Compact Steep Spectrum (CSS) radio galaxy, 3C 305, in which the X-ray radiation appears to be associated with the optical emission line region, marked by the [O III]5007.

On the basis of a morphological study, performed using the comparison between the X-rays (Chandra), the optical (HST) and the radio (VLA) data, we argue that the high energy emission has a thermal nature.

Finally, we discuss the origin of the extended X-ray structure connected with the optical emission line region following two different interpretations: as due to the interaction between matter outflows and shock-heated environment gas, or as due to gas photoionized by nuclear emission.

The XMM-Newton hardest X-ray sky

S. Mateos[(1)], *G.C. Stewart*[(1)], *M.G. Watson*[(1)], *F.J. Carrera*[(2)]

[(1)]University of Leicester, Department of Physics and Astronomy LE1 7RH, Leicester, UK
[(2)]Instituto de Fisica de Cantabria (CSIC-UC), 39005, Santander, Spain

Full knowledge of the X-ray properties and evolution of the obscured AGN population is essential to connect the AGN properties to the accretion history of SMBH and to understand galaxy formation and evolution. X-ray surveys at energies above a few keV provide the most complete and unbiased samples of AGN, since they are least affected by intrinsic absorption and have minimal contamination by processes not related to black hole activity. Exploiting the unique hard X-ray capabilities of XMM-Newton we constructed the largest bright, flux (4.5-10 keV)>$6x10^{-14}$ cgs, flux-limited sample of hard-band (4.5-10 keV) X-ray selected sources (261 objects in total) to date, drawn from a total sky area of ~40 deg^2. Our sample is derived only from XMM-Newton fields imaged by the SDSS-DR7 survey so all sources are covered in 5 optical bands. At present, ~70% of the objects have spectroscopic identifications (from SDSS, the literature and our own follow-up campaign). Our objects are bright enough in both the optical and X-rays to allow a detailed study of their properties and evolution in contrast to more popular small-area medium-deep surveys. We will present results of the multiwavelength properties of our sample, with emphasis on the absorbed AGN population and the implications of the results of our analysis for X-ray background synthesis models.

The X-ray view of the CSS quasar 3C 186

G. Migliori[(1)], *A. Siemiginowska*[(2)], *A. Celotti*[(1)]

[(1)]SISSA/ISAS, 2-4 Beirut, Trieste, Italy
[(2)]Center for Astrophysics, 60 Garden street, Cambridge, MA, USA

We present a complete study of the Compact Steep Spectrum (CSS) quasar 3C186. The X-ray spectral analysis based on a new Chandra observation leaves the origin of the X-ray emission undefined. We discuss the possibility that the X-ray emission is originated in the extended components, jets hot spots and lobes, applying the models for the X-ray emission currently adopted for the giant radio sources.

The broadband Spectral Energy Distribution and the peculiarly high radio loudness of the source are also analyzed in the frame of the evolution of radio sources.

The X-ray spectral properties and variability of AGN in the Chandra/SWIRE Survey

M. Molina[(1)]*, M. Polletta*[(1)]*, L. Chiappetti*[(1)]*, L. Paioro*[(1)]*, G. Trinchieri*[(2)] *and the Chandra/SWIRE collaboration*

[(1)]IASF-INAF, Via Bassini 15, 20133 Milan, Italy
[(2)]IASF-Osservatorio Astronomico di Brera, Via Brera 28, 20121 Milan, Italy

The Chandra/SWIRE survey comprises a rich set of multi-wavelength data, including X-ray observations from Chandra and XMM-Newton, multi-band ground-based optical images, infrared observations from the SWIRE Legacy project, and extremely deep radio observations covering a 0.6 square degrees area in the northern part of the Lockman Hole. Here, we present recently acquired XMM-Newton observations and compare them with previous Chandra observations with the goal of characterizing the X-ray spectral properties and variability of the brightest X-ray sources. We also announce the opening of the Chandra/SWIRE on-line database. The database gives access to the multi-wavelength catalogs, images, spectral energy distributions, and redshifts of all X-ray sources in the field. A possible usage and capability of the database is illustrated by selecting a sample of AGN through the available multi-frequency radio data and retrieving the available multi-wavelength data to constrain their spectral properties, accretion rates, and absorption.

The *INTEGRAL* Complete Sample of Type 1 AGN

M. Molina[(1)], *L. Bassani*[(2)], *A. Malizia*[(2)], *J.B. Stephen*[(2)], *A.J. Bird*[(3)], *A.J. Dean*[(3)], *F. Panessa*[(4)], *A. De Rosa*[(4)], *R. Landi*[(2)]

[(1)]INAF-IASF Milano, Via Bassini 15, 20133 Milano, Italy
[(2)]INAF-IASF Bologna, Via Gobetti 101, 40129 Bologna, Italy
[(3)]School of Physics and Astronomy, University of Southampton, SO17 1BJ, Southampton, UK
[(4)]INAF-IASF Roma, Via del Fosso del Cavaliere 100, 00133 Rome, Italy

We present the broad-band X-ray characteristics of a complete sample of 36 type 1 AGN, detected by *INTEGRAL* in the 20-40 keV band above the 5.5 σ level. For all the objects in the sample, broad-band (1-110 keV) spectra obtained by using *INTEGRAL*/*SWIFT*/*BAT* observations together with *XMM-Newton*, *Chandra*, *ASCA* and *Swift*/*XRT* are analysed.
We also present the general average properties of the sample, i.e. the distribution of photon indices, high energy cut-offs, reflection fractions and absorption properties, together with an in-depth analysis of their parameter space. We find that the average Seyfert 1 power law has an index of 1.74±0.03 with a dispersion of 0.19 and a cut-off energy of 109±58 keV; the average amount of Compton reflection is 1.5±0.2. We do not find any convincing correlation between the various parameters, an indication that our analysis is not strongly dependent by the interplay between them. Finally, we investigate how the results of our analysis fit into current frameworks for AGN spectral modeling and Cosmic Diffuse X-ray Background synthesis models.

The TANAMI Program: Tracking Active Galactic Nuclei with Austral Milliarcsecond Interferometry

C. Müller[(1)]*, Kadler*[(1)]*, Ojha*[(2)] *for the TANAMI Team*

(1)Remeis Observatory, Sternwartstraße 7, 96049 Bamberg, Germany & ECAP, Erlangen, Germany
(2)USNO

We present first results from the TANAMI, a monitoring program to study the structure and dynamics of relativistic jets in active galactic nuclei (AGN). TANAMI is a unique complement to other ongoing VLBI monitoring programs of AGN as it focuses on sources south of -30 degrees declination. The observations are being conducted bimonthly at 8.4GHz and 22GHz with the Australian Long Baseline Array and transoceanic antennas achieving milliarcsecond resolution imaging of the AGN jets' parsec scale structure and variability. Gamma-ray blazars found by the Large Area Telescope (LAT) of the Fermi Gamma-ray Space Telescope are sources of special interest to TANAMI since the combination of gamma-ray and other wavelength observations with VLBI information is crucial to understanding the physical properties of AGNs. We will discuss the radio-jet properties of Fermi-detected AGN and compare them to gamma-ray faint sources.

An X-ray Spectral Model for Compton-Thick Toroidal Reprocessors

K. D. Murphy(1), *T. Yaqoob*(2,3)

(1)MIT Kavli Institute for Astrophysics and Space Research, 77 Massachusetts Avenue, NE80-6013, Cambridge, MA 02139
(2)Department of Physics and Astronomy, Johns Hopkins University, Baltimore, MD 21218
(3)Astrophysics Science Division, NASA/Goddard Space Flight Center, Greenbelt, MD 20771

The central engines of both type 1 and type 2 AGNs are thought to harbor a toroidal structure that reprocesses high-energy photons from the central X-ray source. Unique features in the reprocessed spectra can provide powerful physical constraints on the geometry, column density, element abundances, and orientation of the circumnuclear matter. The calculation of such spectra that are suitable for direct fitting to X-ray data is challenging because the reprocessed emission depends on the spectral shape of the incident continuum, which may not be directly observable. We present new, fully-relativistic Monte-Carlo calculations of Green's functions for a toroidal reprocessor that enables the construction of X-ray spectral fitting models that allow for arbitrary incident spectra and provides other significant improvements over currently available models. The calculations have been performed for column densities that cover the Compton-thin to Compton-thick regime and treat the reprocessed continuum and fluorescent line emission due to Fe Kα, Fe Kβ, and Ni Kα self-consistently, eliminating the need for *ad hoc* modeling that is currently common practice. The spectral shape of the Compton-thick reflection spectrum in the X-ray band from our toroidal geometry differs significantly from that obtained from disk models that are often used to mimic this component. We present applications of our model to some high-resolution AGN spectra.

Multiwavelength Properties of Obscured AGNs Selected from the XMM-Newton Serendipitous Source Catalogue

K. Noguchi, Y. Terashima, H. Awaki

Ehime University, Bunkyo 2-5 Matsuyama, Ehime, Japan

We construct a new sample of obscured AGNs and investigate their X-ray spectra, multiwavelength properties, and structure around the nucleus. A scattering fraction, which is the fraction of scattered emission with respect to direct emission, can be used to estimate the opening angle of the obscuring matter. We select a new sample consisting of 38 AGNs covering a broad range of the scattering fraction (0.1-10%) from the XMM-Newton serendipitous source catalogue. We analyze spectra obtained with XMM-Newton and/or Suzaku to calculate scattering fractions. Eight among 38 objects have a very low scattering fraction (<0.3%), and are most probably *buried* AGNs. We investigate a correlation between the scattering fractions and multiwavelength properties. An [O III]lambda5007 luminosity at a given X-ray luminosity for AGNs with a small scattering fraction tend to be smaller than those with a large scattering fraction. This result is in accordance with the expectation that a size of narrow line region is small because of the small opening angle of the torus. There is no correlation between scattering fractions and far-infrared luminosities, which is often used to estimate the contribution of starburst. This implies that a scale height of the torus is not primarily determined by starburst activity. We also compare scattering fractions with black hole masses or Eddington ratios, and find a weak anti-correlation between Eddington ratios and scattering fractions.

The Soft X-ray spectrum of NGC 4051: a CLOUDY approach

A.A. Nucita[(1)], *M. Guainazzi*[(1)], *A.L. Longinotti*[(2)], *M. Santos-Lleo*[(1)], *S. Bianchi*[(3)]

[(1)]XMM-Newton Science Operations Centre, ESAC, ESA, PO Box 78, 28691 Villanueva de la Canada Madrid, Spain
[(2)]MIT Kavli Institute for Astrophysics and Space Research 77 Massachusetts Avenue, NE80-6011 Cambridge, MA 02139
[(3)]Dipartimento di Fisica, Universit\`a degli Studi Roma Tre, via della Vasca Navale 84, 00146 Roma, Italy

The physical properties of the line emitting material in AGNs can be derived from well known line diagnostics related to H-like and He-like transitions. Here, we show how to get this information (U, ne, nh, size and geometry of the emitting clouds) by a step-by-step fit procedure of the overall observed spectrum with theoretical models developed by using the photoionization code CLOUDY. Application to NGC 4051 low flux state is given.

Deep X-ray observations of the young quasar, PKS1549-79

P. O'Brien[(1)], *V. Braito*[(1)], *J. Reeves*[(2)], *C. Tadhunter*[(3)]

[(1)]Department of Physics and Astronomy, University of Leicester, University Road, Leicester, LE1 7RH, UK
[(2)]Astrophysics Group, School of Physical and Geographical Sciences, Keele University, Keele, Staffordshire, ST5 5BG, UK
[(3)]Department of Physics and Astronomy, University of Sheffield, Western Bank, Sheffield, S10 2TN, UK

We present the first high-quality X-ray observations of the powerful radio-loud AGN, PKS1549-79. This low-redshift (z=0.1523) object is believed to have undergone a recent merger. Extensive multi-wavelength data show it has complex observational characteristics which span many classes of active galaxy, including quasars, radio galaxies, Narrow-line Seyfert 1s, Ultra-Luminous Infrared Galaxies and sub-mm detected high-redshift AGN. Overall, PKS1549-79 has several properties in common with a young proto-quasar which is accreting at a high rate driven by a merger. Such objects are thought to have been common in the early Universe, but as PKS1549-79 is local it is relatively bright enabling detailed study. Understanding such objects is important if we are to make sense of lower-quality data for high-redshift AGN.

We recently used *XMM-Newton* and *Suzaku* to obtain the first deep X-ray observations of PKS1549-79 in order to probe the continuum and emission/absorption properties of this recent, powerful galaxy merger. Using these data we search for nuclear obscuring material and the massive, ionized outflow predicted by galaxy evolution models in order to complete the census of outflow components in this object. We also compare the properties of PKS1549-79 with other AGN proposed to have massive outflows.

Suzaku Precise Measurement of the Hard X-ray Continuum from the Compton-thin Seyfert 2 Galaxy NGC 2110

T. Okajima[1,2]*, J.N. Reeves*[3]*, A.G. Markowitz*[4]*, T. Yaqoob*[2]*, Y. Fukazawa*[5]*, A. Bamba*[6]*,*
Y. Haba[7]*, J. Kataoka*[8]*, T. Mizuno*[5]*, A. Ptak*[2]*, P. J. Serlemitsos*[1]*, T. Takahashi*[6]*,*
Y. Terashima[9]*, Y. Ueda*[10] *and S. Watanabe*[6]

[1]Astrophysics Science Division, Code 662, NASA's Goddard Space Flight Center, 8800 Greenbelt Road, Greenbelt, MD 20771, USA
[2]Department of Physics and Astronomy, Johns Hopkins University, 3400 N Charles Street, Baltimore, MD 21218, USA
[3]Astrophysics Group, School of Physical and Geographical Sciences, Keele University, Keele, Staffordshire ST5 5BG, UK
[4]Center for Astrophysics and Space Sciences, University of California, San Diego, MC 0424, La Jolla, CA, 92093-0424, USA
[5]Department of Physical Science, Hiroshima University, 1-3-1 Kagamiyama, Higashi-Hiroshima, Hiroshima 739-8526, Japan
[6]Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan
[7]Department of Physics, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8602, Japan
[8]Department of Physics, Tokyo Institute of Technology, Meguro, Tokyo 152-8551, Japan
[9]Department of Physics, Ehime University, 2-5 Bunkyocho, Matsuyama, Ehime 790-8577, Japan
[10]Department of Astronomy, Kyoto University, Sakyo-ku, Kyoto 606-8502, Japan

NGC 2110 was observed at its brightest state ever in the observation history from 1978. The 2-10 keV flux is 1.05×10^{-10} ergs cm^{-2} s^{-1}, which is about three times higher than a historical average. Suzaku was able to get a high quality spectrum up to 200 keV with a 100-ksec exposure, which allows us to study a Compton reflection and a high energy cut-off. The overall broad-band spectrum can be modeled by a single power-law with a photon index of 1.8 and it requires multiple absorption. The stringent limit on the reflection component with HXD of $R<0.1$ implies an origin in Compton-thin matter, while the high energy cut-off is restricted to >200 keV. A weak iron line was barely resolved and the line width is found to be <5500 km s^{-1} (FWHM) at 6.4 keV. However, no diskline component is found. The soft excess component is also seen below 1 keV, which can be explained as a scattering of the nuclear radiation rather than a thermal emission as is interpreted in the previous measurements. In fact, the 0.5-2.4 keV flux is about one order of magnitude higher than before.

The multiwavelength campaigns on the flaring Gamma-ray blazars detected by AGILE

L. Pacciani[(1)] *, A. Bulgarelli*[(2)] *, A. W. Chen*[(3-4)] *, F. D'Ammando*[(1-5)]*, I. Donnarumma*[(1)]*,*
A. Giuliani[(3)]*, G. Pucella*[(6)]*, S. Vercellone*[(7)]*, V. Vittorini*[(1-4)] *on behalf of the AGILE team*

[(1)]IASF-Roma/INAF, Via Fosso del Cavaliere 100, I-00133, Rome, Italy
[(2)]IASF-Bo/INAF, Via Gobetti 101, I-40129, Bologna, Italy
[(3)]IASF-Mi/INAF, Via E. Bassini 15, I-20133, Milano, Italy
[(4)]CIFS, Viale Settimio Severo 63, I-10133, Torino, Italy
[(5)]Univ. Degli Studi di Roma "Tor Vergata", Via della Ricerca Scientifica 1, I-00133, Roma, Italy
[(6)]ENEA Frascati, Via E. Fermi 45, I-00044, Frascati (Roma), Italy
[(7)]IASF-Pa/INAF, Via U. La Malfa,153, I-90146, Palermo, Italy

We report the results of the MWL campaigns on seven flaring blazars detected by the AGILE mission. We achieved an almost continuous coverage of the FSRQ 3C 454.3. The source exhibited flux above $10\times E^{-6}$ gamma/cm^2/s (E > 100 MeV) and day by day variability during all the AGILE observing periods (EGRET detected high activity only once). An other blazar, PKS 1510-089 was frequently found in high activity.

S5 0716+71, an intermediate BL Lac object, has shown a very high gamma-ray activity and fast variability during a period of intense optical activity. The estimated jet power exceeds 3×10^{45} erg/s, comparable or higher than the maximum power extractable from a spinning black hole of 10^9 solar masses.

During two MWL campaigns, we observed gamma-ray activity from two FSRQ of the Virgo region: 3C 279 and 3C 273. We detected high activity from W Comae, a BL Lac object, and Mrk 421, an high energy peaked BL Lac object. For this source, a campaign from optical to TeV has been performed.

The obtained broadband variability and spectral energy distribution give stringent constraints on the emission mechanisms of the observed sources.

Unabsorbed Seyfert 2 galaxies: the case of "naked" AGN

F. Panessa[(1)], *F.J. Carrera*[(2)], *S. Bianchi*[(3)], *A. Corral*[(4)], *F. Gastaldello*[(5,6,7)], *X. Barcons*[(2)], *L. Bassani*[(8)], *G. Matt*[(3)], *L. Monaco*[(9)]

[(1)]Istituto di Astrofisica Spaziale e Fisica Cosmica (IASF-INAF), via del Fosso del Cavaliere 100, 00133 Roma, Italy
[(2)]Instituto de Fisica de Cantabria (CSIC-UC), 39005 Santander, Spain
[(3)]Dipartimento di Fisica, Università degli Studi Roma Tre, via della Vasca Navale 84, 00146 Roma, Italy
[(4)]Osservatorio Astronomico di Brera (OAB-INAF), via Brera 28, 20121 Milano, Italy
[(5)]IASF-Milano, INAF, via Bassini 15, Milano 20133, Italy
[(6)]Department of Physics and Astronomy, University of California at Irvine, 4129, Frederick Reines Hall, Irvine, CA 92697-4575
[(7)]Occhialini Fellow
[(8)]Istituto di Astrofisica Spaziale e Fisica Cosmica (IASF-INAF), Via P. Gobetti 101, 40129 Bologna, Italy
[(9)]Universidad de Concepciòn, Casilla 160-C, Concepciòn, Chile

Hawkins (2004) reported on a class of "naked" AGN characterized by strong amplitude optical brightness variability and the complete absence of broad emission lines in the optical spectrum. The variability suggests that the nucleus is seen directly, however the absence of broad lines contradicts the simple formulation of Unified Models for AGN. We present the results of quasi simultaneous spectroscopic observations with XMM-Newton and NTT (La Silla) of two "naked" AGN. We confirm the "naked" nature of Q2131-427 for which no broad emission line components have been detected in the optical spectrum and its X-ray spectrum shows no signs of intrinsic absorption. The optical and X-ray mismatch in this source cannot be ascribed to a high nuclear dust-to-gas ratio and a Compton Thick nature is ruled out. The Broad Line Region (BLR) may be completely absent in this source, possibly as a consequence of its low Eddington ratio. On the other hand, the optical spectrum of Q2130-431 shows H(alpha) and H(beta) broad emission line components, revealing the presence of a BLR. A mild X-ray absorption is expected in intermediate type 1.8 Seyfert galaxies like Q2130-431, however we put a very low upper limit on the column density, also the low Balmer decrement suggests that the BLR itself does not suffer from reddening. We propose that in this object the BLR is instrinsecally weak, making a case of "true" intermediate Seyfert galaxy.

The restless nature of AGNs: X-ray variability from Chandra and XMM

M. Paolillo, *V. Allevato, C. Pinto*

Università Federico II, C.U: Monte S.Angelo, via Cintia, Napoli, Italy

AGNs are typically variable on timescales ranging from days to months. I will review the results of X-ray variability studies with Chandra and XMM in deep multi-epoch surveys, focusing on the results from the Chandra Deep Field South.

Optical identification of Swift/BAT hard X-ray sources

P. Parisi et al.

INAF/IASF di Bologna, Italy and University of Bologna, Italy

Through an optical campaign performed at telescopes located in the Northern and the Southern Hemispheres, we have obtained optical spectroscopy of candidate counterparts of unidentified hard X-ray sources detected with *Swift*/BAT. Here we present the preliminary analysis of these optical spectra, which allowed us to firmly determine the nature of these objects.

Type 2 Quasars at the heart of high-z extremely dust obscured galaxies in SWIRE

E. Piconcelli(1), *G. Lanzuisi*(1,2), *F. Fiore*(1), *C. Feruglio*(3), *C. Vignali*(4,5), *M. Salvato*(6), *C. Gruppioni*(5)

(1)Osservatorio Astronomico di Roma (INAF), via Frascati 33, 00040 Monteporzio Catone, Italy
(2)Dipartimento di Fisica, Università di Roma La Sapienza, P.le A. Moro 2, 00185 Roma, Italy
(3)CEA, Irfu, Service d'Astrophysique, Centre de Saclay, 91191 Gif-sur-Yvette, France
(4)Dipartimento di Astronomia, Università di Bologna, via Ranzani 1, 40127 Bologna, Italy
(5)Osservatorio Astronomico di Bologna (INAF), via Ranzani 1, 40127 Bologna, Italy
(6)Caltech, MC 105-24, 1200 East California Blvd, Pasadena, CA 91125, USA

Optical to Mid-IR color selections have been recently used to uncover a population of extremely dust obscured galaxies (DOGs) at high redshifts. IR and optical follow-up observations have suggested the presence of strong AGN activity at the heart of these systems. Nonetheless, their X-ray properties have remained largely unknown until now. Here we report on an X-ray spectroscopic study of a large sample of bright DOGs selected from a 6 deg^2 region within the SWIRE fields. The application of our mid-IR selection criteria to a large area survey has been capable of unveiling a population of X-ray luminous, absorbed quasars that is mostly missed in the traditional surveys. This intriguing class of obscured quasars at high-z will be discussed in the context of a complete census of SMBHs and the cosmological evolution of AGNs and their host galaxies.

AGN Spectral Energy Distributions: intrinsic differences and possible origins

M. Polletta(1), *L. Maraschi*(2), *L. Chiappetti*(1), *G. Trinchieri*(2)

(1)INAF-IASF Milano, via E. Bassini 15, 20133 Milano, Italy
(2)Osservatorio di Brera, via Brera 28, 20121 Milano, Italy

AGN exhibit a variety of spectral energy distributions whose shapes depend mainly on the amount of extinction suffered by the nuclear light, the contribution of the host galaxy, and the intrinsic properties of the AGN. Here, the intrinsic AGN spectral energy distributions are characterized after removing the host contribution and taking into account the effects of obscuration and absorption. The analysis is applied to a hard X-ray selected sample of AGN from the XMM-Newton Medium Deep survey. The survey benefits from a rich multi-wavelength coverage, from radio to X-rays, and has detected hundreds of AGN in the hard X-rays at z=0.2-3. We distinguish two types of AGN with different intrinsic spectral energy distributions whose shapes are independent of luminosity, host properties and obscuration. The possible origins of such difference are discussed.

AGN properties in a cosmological evolution scenario

S. I. Raimundo, *A.C. Fabian*

Institute of Astronomy, Madingley Road, Cambridge CB3 0HA, UK

To understand how AGN accrete, evolve and affect the surrounding galaxy, it is necessary to investigate how their intrinsic properties change with time. We consider different AGN populations, accounting for their physical properties, obscuration and spectral features, and trace their redshift evolution. In particular, we investigate the role of Eddington ratio and accretion efficiency in the black hole mass function, and build a scenario where objects with a high spread in Eddington ratios, including low values (10^{-3} - 10^{-2}) are consistent with the observed local mass function. We find that in general, the black holes in our solutions are spinning rapidly, especially the ones with low hydrogen column densities. An evolutionary model will be presented.

The XMM-Newton Slew Survey: The Whole X-ray Sky and the Rarest X-ray Events

A.M. Read (1), *R.D. Saxton*(2), *P. Esquej*(1), *R.S. Warwick*(1)

(1)University of Leicester, Leicester, LE1 7RH, UK
(2)XMM SOC, ESAC, Villanuevade la Canada, Madrid, Spain

The data collected by XMM-Newton as it slews between pointings currently cover almost half of the whole sky, and these latest near-'all-sky' X-ray views of the cosmos are presented here. Many new sources and familiar features, including the brightest sources in the sky, are visible, as is the history, coverage and depth of the survey. With the recent release of our third update to the Slew Survey Catalogue, we are able here to present significant new developments and highlights; The soft-band (0.2-2 keV) sensitivity limit of the Slew is close to that of the RASS, and a large-area RASS-Slew comparison now provides the best opportunity for discovering extremely rare high-variability objects, and a number of examples of these are presented here. The hard-energy (2-12 keV) slew survey goes significantly deeper than all other previous large area surveys, and many new hard X-ray sources have been discovered. We also discuss the prospects, both of XMM-Newton, as it continues to amass data over a larger and larger fraction of the sky and to greater and greater depths, and also of future missions and beyond.

Compton Thick Winds in Radio-Quiet AGN – the Case of PDS 456

J. Reeves[(1)], *P.T. O'Brien*[(2)], *V. Braito*[(2)], *E. Behar*[(3)], *L. Miller*[(4)], *T.J. Turner*[(5)], *A.C. Fabian*[(6)], *S. Kaspi*[(7)], *R. Mushotzky*[(3)], *M. Ward*[(8)]

[(1)]Astrophysics Group, School of Physical and Geographical Sciences, Keele University, Keele, Staffordshire, ST5 0DU, UK
[(2)]Department of Physics and Astronomy, University of Leicester,
University Road, Leicester LE1 7RH, UK
[(3)]Astrophysics Division, NASA Goddard Space Flight Center, Greenbelt Road, Greenbelt, MD20771, USA
[(4)]Dept of Physics, University of Oxford, Denys Wilkinson Building, Keble Road, Oxford OX1 3RH, UK
[(5)]Joint Center for Astrophysics, University of Maryland Baltimore County, 1000 Hilltop Circle, Baltimore, MD21250, USA
[(6)]Institute of Astronomy, Madingley Road, Cambridge CB3 0HA, UK
[(7)] Department of Physics, Technion, Haifa 32000, Israel
[(8)] Dept of Physics, University of Durham, South Road, Durham DH1 3LE, UK

We discuss evidence for near Compton-thick outflows in luminous type I AGN, which may originate from the inner accretion disk wind. In particular a Suzaku observation of the type I quasar PDS 456 shows evidence for a highly ionized outflow on the basis of iron K-shell absorption, with velocities measured of the order 0.25c, implying an origin from the innermost accretion disk. Drastic variations in all the spectra of PDS 456 over the course of a decade are likely due to changes in the line of sight covering fraction of the quasar disk wind. High column density (Compton-thick) absorption may also be present in the radio-quiet quasar 1H 0419-577 and the NLS1 NGC 4051, which both show very strong excesses in flux in the hard X-ray band with Suzaku HXD, similar to another recently reported hard excess in the changing-look Seyfert NGC 1365 with Suzaku. However such components are not detected thus far in radio-loud AGN, suggesting a dichotomy in the production of winds/jets between radio-quiet/radio-loud AGN. Finally we discuss whether the disk winds can contribute significantly to cosmic feedback in terms of their energetics. In the case of PDS 456, the wind likely subtends 20% of 4pi steradian, with a plausible energy output of 10^{60} erg/s over the quasar lifetime.

15 GHz Monitoring of Gamma-ray Blazars with the OVRO 40 Meter Telescope in Support of Fermi

J.L. Richards[1], *W. Max-Moerbeck*[1], *V. Pavlidou*[1], *T.J. Pearson*[1], *A.C.S. Readhead*[1], *M.A. Stevenson*[1], *S.E. Healey*[2], *R.W. Romani*[2], *M.S. Shaw*[2], *E. Angelakis*[3], *L. Fuhrmann*[3], *J.A. Zensus*[3], *K. Grainge*[4], *G.B. Taylor*[5]

[1]California Institute of Technology, Owens Valley Radio Observatory, 1200 E. California Blvd. M/C 249-17, Pasadena, CA 91125, USA
[2]Department of Physics/KIPAC, Stanford University, Stanford, CA 94305, USA
[3]Max-Planck-Institut für Radioastronomie, Auf dem Huegel 69, Bonn 53121, DE
[4]Astrophysics Group, Cavendish Laboratory, J J Thomson Avenue, Cambridge CB3 0HE, UK
[5]Department of Physics and Astronomy, University of New Mexico, Albuquerque, NM 87131, USA

Since mid-2007, we have been monitoring ~1200 sources at 15 GHz with the 40m telescope at the Owens Valley Radio Observatory. Our sample includes the 1158 blazars north of -20 degrees declination in the Candidate Gamma-Ray Blazar Survey (CGRaBS), as well as other sources, many observed in cooperation with investigators at other wavelengths. Our sample is monitored at least twice per week, yielding long, densely-sampled light curves. We use the 40m telescope in an azimuth double-switched mode with 2.5 arcmin beams and obtain a 5 mJy thermal noise floor. Flux densities in our sample range from about 10 mJy to 30Jy with a median of 300mJy.

A large fraction of the sources in our sample exhibit significant variation in 15 GHz flux density. This allows classification of our blazars into subpopulations based on their variability, comparison of radio variability with optical classification, calculation of variability Doppler factors, and cross-correlation with simultaneous time-domain behavior in other bands. In particular, we compare our radio light curves with gamma-ray data from the Fermi Gamma-ray Space Telescope Large Area Telescope (LAT). We also compare a subset of our sources with monthly 2.6 GHz–1mm radio spectra obtained by the F-GAMMA project with the Effelsberg 100 m and IRAM 30 m telescopes.

Revealing X-ray luminous AGN in apparent starburst galaxies

F.E. Jackson[(1)], T.P. Roberts[(1)], J.M. Gelbord[(1)], M.J. Ward[(1)], J.L. Wardlow[(1)], D.M. Alexander[(1)] and M.G. Watson[(2)]

[(1)]Dept of Physics, Durham University, South Road, Durham DH1 3LE, United Kingdom
[(2)]X-ray & Observational Astronomy Group, Dept of Physics & Astronomy, University of Leicester, University Road, Leicester LE1 7RH, United Kingdom

It is commonly assumed in deep survey work that all galaxies with X-ray luminosities above about 10^{42} erg s^{-1} harbour AGN, regardless of their optical spectrum, due to the absence of starburst galaxies in the local Universe reaching such extreme luminosities. We investigate the validity of this assumption using new *Chandra* and *XMM-Newton* observations of three relatively nearby ($z \sim 0.1$) starburst galaxies, chosen on the basis of their SDSS optical spectrum, and their coincidence with a bright X-ray source from the 2XMM catalogue. If originating from the galaxy in question, the X-ray luminosity is in each case greater than 10^{42} erg s^{-1} (and in one case reaches 10^{43} erg s^{-1}), meaning these would be the most X-ray luminous starburst galaxies yet discovered if no AGN were present. However, the new X-ray data shows two of the three sources to display X-ray spectral and temporal variability between observations, with all three appearing point-like at Chandra resolution. Furthermore they are spectrally dissimilar to starburst X-ray emission, possessing power-law dominated spectra more reminiscent of AGN. We therefore conclude that otherwise innocuous AGN are indeed fueling the X-ray emission from these galaxies, and that the assumption starburst galaxies do not exceed 10^{42} erg s^{-1} remains observationally justified.

Gamma-ray quiet BL Lacs: a *Swift* view

P. Romano, S. Vercellone, B. Sbarufatti

INAF-IASF Palermo, Via Ugo La Malfa 153, 90146 Palermo, Italy

We present the spectral energy distributions of a small sample of gamma-ray quiet BL Lacs and flat-spectrum radio quasars that we observed with *Swift* and compare them with those of gamma-ray loud blazars. We exploit *Swift*'s broad-band spectral capabilities and pointing flexibility to examine any possible difference and/or similarity between the synchrotron to inverse Compton transition region of gamma-ray loud and gamma-ray quiet blazars.

Mult-wavelength observations of the Lockman Hole

E. Rovilos[(1)], *V. Burwitz*[(1)], *G. Hasinger*[(1,2)], *E. Egami*[(3)], *G. Szokoly*[(4)]

[(1)]Max Planck Institut für extraterrestrische Physik, Giessenbachstraße, 85748 Garching, Germany
[(2)]Max Planck Institut für Plasmaphysik, Boltzmannnstraße 2, 85748, Garching, Germany
[(3)]Steward Observatory, University of Arizona, 933 North Cherry Avenue, Tucson, AZ 85721, USA
[(4)]Institute of Physics, Eötvös University, Pázmány P.s. 1/A, 1117 Budapest, Hungary

We present the results of deep multi-wavelength observations in the Lockman Hole, in a region covering the deepest (800ks) XMM observation. We have used the Large Binocular Telescope to image the Lockman Hole in the U, B, and V bands with integration times of several (up to 20 in the U band) hours, which resulted in the deepest ground-based images in these bands. A large number of sources has been revealed (~85000) down to 28.5mag(AB) which provides optical counterparts for up to >80% of the X-ray sources. Combined with deep r-i-z images taken with the Subaru telescope and NIR images taken with Spitzer, this survey provides an excellent framework to study the multi-wavelength properties of faint X-ray sources. The good spectral coverage also allows us to derive photometric redshifts for many of these sources. Finally there is a well of public information for the Lockman Hole area, spanning from the far-ultraviolet to meter-wave radio, making it an ideal place for the study of different classes of extragalactic objects.

Comparing hard X-ray and mid-IR spectra: a hint of the structure of ULIRG-hosted AGNs

E. Sani[1], *G. Risaliti*[2,3], *M. Salvati*[2]

[1]Dipartimento Astronomia Universita` di Firenze, L.go E. Fermi 2, I-50125 Firenze
[2]INAF- Osservatorio Astrofisico di Arcetri, L.go E. Fermi 5, I-50125 Firenze
[3]Harvard-Smithsonian Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138

We present a new characterization of the absorbing medium properties in AGN hosted by ULIRGs. Our study combines the 1-100 keV analysis, from observations with BeppoSax/PDS, XMM-Newton and Chandra, with Spitzer-IRS mid-Infrared results.

Our aims are (a) to investigate the obscuring torus geometry and reflection efficiency for the cold gas component and, (b) to identify possible Compton thick AGNs not detected at other wavelegths.

The main results are the following:

- In most cases the observed X-ray flux is significantly lower than the expected pure reflected emission, suggesting a lower reflection efficiency in AGNs hosted by ULIRG compared to the standard Seyfer scenario.
- Among the 2-10 keV Compton thick sources, IRAS 12072-0444 shows an intense 20-100 excess, with an intrinsic luminosity exceeding 10^44 erg/s.
- Heavily obscured AGN hosted in ULIRG may present a complete covering geometry of the obscuring medium rather than a toroidal one. IRAS 08572+3915 is the best example.

The Extragalactic 2-10 keV X-ray Source Counts at Bright Fluxes

R. D. Saxton[(1)] , *R. S. Warwick*[(2)], *A.M. Read*[(2)], *P. Esquej* [(2)]

[(1)]XMM SOC, ESAC, 28691 Villanueva de la Cañada, Madrid, Spain
[(2)]Department of Physics and Astronomy, University of Leicester, Leicester, UK.

Over the last four decades, the statistical properties of the extragalactic X-ray sky in the classical 2-10 keV band have been revealed through a wide variety of missions and surveys. The early shallow all-sky surveys of Uhuru, Ariel V and HEAO-1 have been complemented in more recent times by both medium sensitivity wide-area surveys (e.g. ASCA, BeppoSax, 2XMM) and very deep, pencil-beam studies (Chandra, XMM-Newton).

The XMM-Newton slew survey (XMMSL1) currently covers 40% of the sky down to a flux limit of 4E-12 ergs/s/cm2 (2-10 keV), which nicely fills in the gap between the currently available shallow and medium-deep surveys. Through use of simulations we derive the "corrected" X-ray 2-10 keV source counts from the XMMSL1 catalogue and consider the match with previous surveys. The various source populations which comprise the slew survey are investigated and a comparison is made with current model predictions for AGN and clusters of galaxies.

Hard X-ray properties of the RASS QSOs in the Palermo BAT Survey

B. Sbarufatti, G. Cusumano, V. La Parola, A. Maselli, A. Segreto

INAF-IASF Palermo, Via U. La Malfa 153, Palermo, Italy

The Burst Alert Telescope (BAT) on board the Swift satellite is performing the deepest hard X-ray survey in the 14-150 keV energy range to date. To make use of this huge amount of data our group developed a dedicated software, the BATIMAGER, which performs data reduction, mosaicking and source detection on the BAT survey data. Besides the production of the all-sky flux and significancemap, the software can be used to check for hard X-ray significant emission in any given list of directions in the sky. Using this capability, we investigated the hard X-ray properties of the QSOs from the Rosat All Sky Survey, which we present here.

The X-ray continuum slope of quasars revisited

A. Scott[1] , *G. Stewart*[1] , *S. Mateos*[1] , *D. Alexander*[2] , *S. Hutton*[2]

[1]Department of Physics and Astronomy, University of Leicester, University Road, Leicester, LE1 7RH, UK
[2]Department of Physics, University of Durham, South Road, Durham, DH1 3LE, UK

We present the X-ray properties of a large, optically selected sample of quasars, from a cross-correlation of the SDSS DR5 quasar catalogue and the x-ray serendipitous source catalogue, 2XMM. The distribution of power law slopes is considered, including its intrinsic dispersion and the dependence of photon index on X-ray luminosity and redshift. In general our results agree with those of Young et al. (2009), however we offer a different interpretation of the correlation of photon index and X-ray luminosity. We find evidence for a correlation of photon index and redshift, (decreasing photon indices for higher redshift sources), and propose that this may be due to a Compton reflection component being redshifted into the XMM-Newton observed energy band, making the power law slope of the sources appear flatter. We attempt to constrain the size of this reflection component by modeling composite spectra of sources in narrow redshift bins. The implications for the physical origin of the continuum of sources with extreme slope values is discussed.

Heavily obscured AGN in the local Universe

P. Severgnini et al.

INAF-Osservatorio Astronomico di Brera, via Brera 28, I-20121, Milano, Italy

On the basis of the most accreditate X-ray synthesis model, heavily obscured (Compton-thick) AGN are predicted to constitute a significant fraction of the total number of AGN. In spite of this, a few dozens of "secure" Compton-thick sources have been detected so far and, in this sense, the Compton-thick AGN Universe is practically a "new" field in high-energy astrophysics.

We present here a new powerful diagnostic plot to select heavily obscured AGN in the local Universe by combining X-ray and infrared information. On the basis of this plot we selected a well defined sample of X-ray sources in the 2XMM catalogue and found new Compton-thick AGN candidates. For some of these, the Compton-thick nature is confirmed by the high-energy BAT spectrum. X-ray analysis of all these new heavily obscured AGN is also presented, and prospects in the characterization of Compton-thick AGN with Herschel are shown.

Correlations between the spectral and timing properties of AGN

M.A. Sobolewska, I.E. Papadakis[1,2]

[1]FORTH/IESL, Voutes, GR-71110, Heraklion, Crete, Greece
[2]University of Crete, GR-71003, Heraklion, Crete, Greece

We present the results from a combined study of the average X-ray spectral and timing properties of 10 nearby AGN. We used all available data from the RXTE archive, which were taken regulary until the end of 2006, that is over a period of ~7– 11 years. The AGN average spectral slopes are correlated with the characteristic frequency in AGN power spectra, when normalised to the sources black hole mass. This can be explained if we assume that the accretion rate determines both the average spectral slope and the characteristic time scales in these systems. The AGN correlation is similar to the spectral-timing correlation observed in Cyg X-1, but not the same. Comptonisation models are broadly consistent with our result, and can explain the difference between Cyg X-1 and AGN, but only if the ratio of the soft photons' luminosity to the power injected to the hot corona is proportionally related to the accretion rate. We also study AGN long term (~7–11 years) spectral variability and compare our results with predictions of several models. Absorption of X-rays by a medium with varying properties fails to explain the data. Variable in flux intrinsic power-law and its constant reflection cannot fit observations in a few objects, and also predicts large average values of reflection amplitude, R. It is possible that both the slope and the flux of the intrinsic power-law change withing each objects, and the reflecting material responds to the average continuum.

The complete X-ray and optical view on BALQSOs

A. Streblyanska, X. Barcons, F. Carrera etc

IFCA (CSIC-UC), Av. Los Castros s/n, Santander, Spain

We present results from the most complete sample of BALQSO observed with the XMM-Newton observatory. We collect information for about 80 sources from the literature and existing catalogues from different surveys. This is the most uniformly-analyzed optical/X-ray BALQSO sample to date. We performed X-ray spectral analysis (using different models) of the sample of sources with best statistics, and hardness ratio analysis of the remaining sources. Using available optical spectra, we calculated the BALnicity Index and other BALnicity indicators for the sources and we investigated the relationship between these optical parameters and different X-ray properties.

Role of the emission angular directionality in the spin determination of accreting black holes with broad iron lines

J. Svoboda[1,2], *M. Dovčiak*[1], *R.W. Goosmann*[3], *V. Karas*[1]

[1]Astronomical Institute of the Academy of Sciences, Boční II 1401/1a CZ-141 31, Prague, Czech Republic
[2]Astronomical Institute of the Faculty of Mathematics and Physics of the Charles University, V Holešovičkách 2 CZ-180 00, Prague, Czech Republic
[3]Observatoire Astronomique de Strasbourg, 11 rue de l'Université 67000, Strasbourg, France

We discuss the method to determine the spin of black holes by employing the broad relativistic iron line profiles in the X-ray domain. The precision of the spectral fitting procedure could be compromised by an inappropriate account for the angular distribution of the disc emission. An isotropic distribution or a particular limb-darkening law have been frequently assumed, although some radiation transfer computations exhibit an emission excess towards grazing angles (limb-brightening). We perform radiation transfer computations of an X-ray irradiated disc atmosphere to constrain the directionality of the outgoing X-rays in the 2-10 keV energy band. We study how sensitive the spin determination is to the assumptions about the intrinsic angular distribution of the emission.

Simultaneous Multiwavelength campaigns on the blazars:
S5 0716+714, 1ES 1426+428 and 1ES 1959+650

G. Tagliaferri[(1)], *D. Bose*[(2)], *L. Foschini*[(1)], *G. Ghisellini*[(1)], *E. Leonardo*[(3)], *N. Mankuzhiyil*[(4)], *I. Oya*[(2)], *S. Rügamer*[(5)], *A. Stamerra*[(3)], *F. Tavecchio*[(1)]

[(1)]INAF – Osservatorio Astronomico di Brera, Via Bianchi 46, 23807 Merate, Italy
[(2)]Universidad Complutense Madrid, Spain
[(3)]Università of Siena, Via Roma 56, Italy
[(4)]University of Udine and INFN Trieste, Italy
[(5)]Universität Würzburg, D-97074 Würzburg, Germany

We performed multi wavelength campaigns on three very active blazars, collecting data from the optical, UV, soft- and hard-X-ray and TeV bands. These observations were performed with the Suzaku, XMM-Newton and Swift satellites, with the MAGIC telescope and other ground based facilities. While S5 0716+714 has been observed while it was in an active state in the very high energy band, 1ES 1426+428 and 1ES 1959+650 were observed in an intermediate state of activity in the optical and X-ray bands and in a very low state in the TeV band. We will present and discuss their flux-spectral variability together with their overall Spectral Energy Distribution of these sources that can be well represented by a homogeneous one-zone synchrotron inverse Compton emission model.

Observational signatures of a black hole

L. Titarchuk

University of Ferrara, Via Saragat, 1 44100 Ferrara (Italy)

We discover a spectral index saturation vs mass accretion rate in a number of Galactic black hole candidates (BHCs) using the comprehensive X-ray spectral data analysis of these sources. This index saturation was predicted as a BH spectral signature using a solution of the full relativistic kinetic equations for the Schwarzchild background and extensive Monte-Carlo simulations of radiative processes in the BH innermost part. Furthermore, I demonstrate the observational evidence of strongly redshifted annihilation line detected from BHC GRS 1915+105 and XTE 1550-564. This BH spectral signature was also predicted and reported in an early work by Philippe Laurent and myself.

New insights for the nuclear environment of radio galaxies with the high resolution X-ray spectroscopy

E. Torresi[1,2] *, P. Grandi*[1]*, G. Palumbo*[2]*, M. Guainazzi*[3]*, A. L. Longinotti*[4]*, A. Nucita*[3]*, F. Tombesi*[2]

[1]INAF-IASFBo,via Gobetti 101, 40129, Bologna, Italy
[2]Dip. di Astronomia, Università degli Studi di Bologna, via Ranzani 1, 40125, Bologna, Italy
[3]European Space Astronomy Centre of ESA P.O.Box 78, Villanueva de la Cañada, E-28691 Madrid, Spain
[4]MIT Kavli Institute for Astrphysics and Space Research 77 Massachussets Avenue, NE80-6011 Cambridge

The launch of *Chandra* and *XMM-Newton* led to an important revolution in the field of X-ray spectroscopy. Both the satellites carry on-board diffraction grating spectrometers with resolving power $E/\Delta E \geq 200$, that allowed to perform for the first time high resolution spectroscopy. We show here new insights that high resolution X-ray spectroscopy provides for the nuclear environment of radio-loud sources, in particular for FRII radio galaxies (RG). Depending on the line-of-sight, different features can be detected. In obscured RGs (seen at high inclination angles) traces of photoionized gas were reavealed as emission lines in the soft X-ray spectra (e.g. 3C 445 and 3C 33). This gas, photoionized by the central engine, is probably located in the Narrow Line Region and does not seem to be related to any jet emission. In unobscured radio galaxies (seen at low inclination angles) the detection of soft X-ray absorption lines reveals the presence of an inner component of highly ionized warm gas ($\log\xi>2$) with column density $\sim10^{22}$ cm^{-2}, analogous to warm absorbers commonly observed in Radio-Quiet (RQ) AGNs. The comparison between the environment properties of Radio-Quiet and Radio-Loud (RL) AGNs, through high resolution spectroscopy, opens up an important and yet unexplored way for investigating RL/RQ dichotomy.

Chandra Observations of NGC 4151 and NGC 1365

J. Wang[(1)], *G. Fabbiano*[(1)], *G. Risaliti*[(1,2)], *M. Elvis*[(1)]

[(1)]Harvard-Smithsonian CfA, 60 Garden St, Cambridge, MA 02138, USA
[(2)]INAF-Arcetri Observatory, Largo E, Fermi 5, I-50125, Firenze, Italy

We present Chandra observations of the circumnuclear regions of two nearby active galaxies, namely the archetypal Seyfert 1 NGC 4151 and the starburst/AGN composite Seyfert 1.8 NGC 1365. We revisit the spectral variability of NGC 4151 nucleus and show that the spectral index is highly dependent on the adopted models. Preliminary results from Chandra HRC imaging resolving the 4 arcsec radio jet and the extended NLR will be discussed. In NGC 1365, the X-ray morphology shows a biconical soft X-ray-emission region extending ~5 kpc in projection from the nucleus, coincident with the optical high-excitation outflow cones, which are studied in details.

Suzaku and XMM-Newton Observations of Type 2 ULIRGs with a High [OIII] Luminosity

Y. Hirata[1], *Y. Terashima*[1], *N. Anabuki*[2], *T. Nakagawa*[3], *H. Awaki*[1]

[1]Ehime University, 2-5 Bunkyou, Matuyama, Ehime 790-8577 ,Japan
[2]Osaka University, Toyonaka, Osaka 590-0043, Japan
[3]ISAS/JAXA, 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan

We present results from observations of type 2 quasar candidates in the ultraluminous infrared galaxies(ULIRGs) IRAS 11223-1244, IRAS 05024-1941, and IRAS 13443+0802 with Suzaku and XMM-Newton. These nuclei are classified as Seyfert 2 based on optical emission line ratios. Their intrinsic [OIII]lambda5007 line luminosities are $1x10^{11}$, $2x10^{10}$, and $5x10^{9}$ Lsolar, respectively, which are in the range of type 2 quasars. Their X-ray spectra are explained by a combination of unabsorbed and absorbed power-law components. An Fe K line is not significantly detected in the spectra; the upper limits on the equivalent widths are 400-630 eV. The absorption-corrected 2-10 keV luminosities L(2-10 keV) are $2x10^{43}$, $6x10^{42}$, and $3x10^{42}$ erg s^{-1}, respectively. These results indicate that these objects are Compton thin AGNs with Seyfert class luminosities and are not type 2 quasars. We compare the far infrared (FIR) luminosities L(FIR) with the bolometric luminosities of the AGNs derived by making bolometric corrections to L(2-10 keV). Since it is suggested that X-rays tend to underestimate the luminosity of AGNs by an order of magnitude compared to other indicators of AGN luminosities (Imanishi & Terashima 2004), we used a bolometric correction factor of 300 as an extreme case and find that the contribution of AGNs to L(FIR) is at most a few %.

A New Understanding of the Relation between X-ray and Optical Emission from Quasars

M. Young[1,2], *M. Elvis*[1], *G. Risaliti*[1,3]

[1]Harvard-Smithsonian Center for Astrophysics, 60 Garden Str., Cambridge, MA 02138, USA
[2]Boston University, 725 Commonwealth Ave., Boston, MA 02215, USA
[3]INAF - Osservatorio di Arcetri, L.go E. Fermi 5,Firenze, Italy

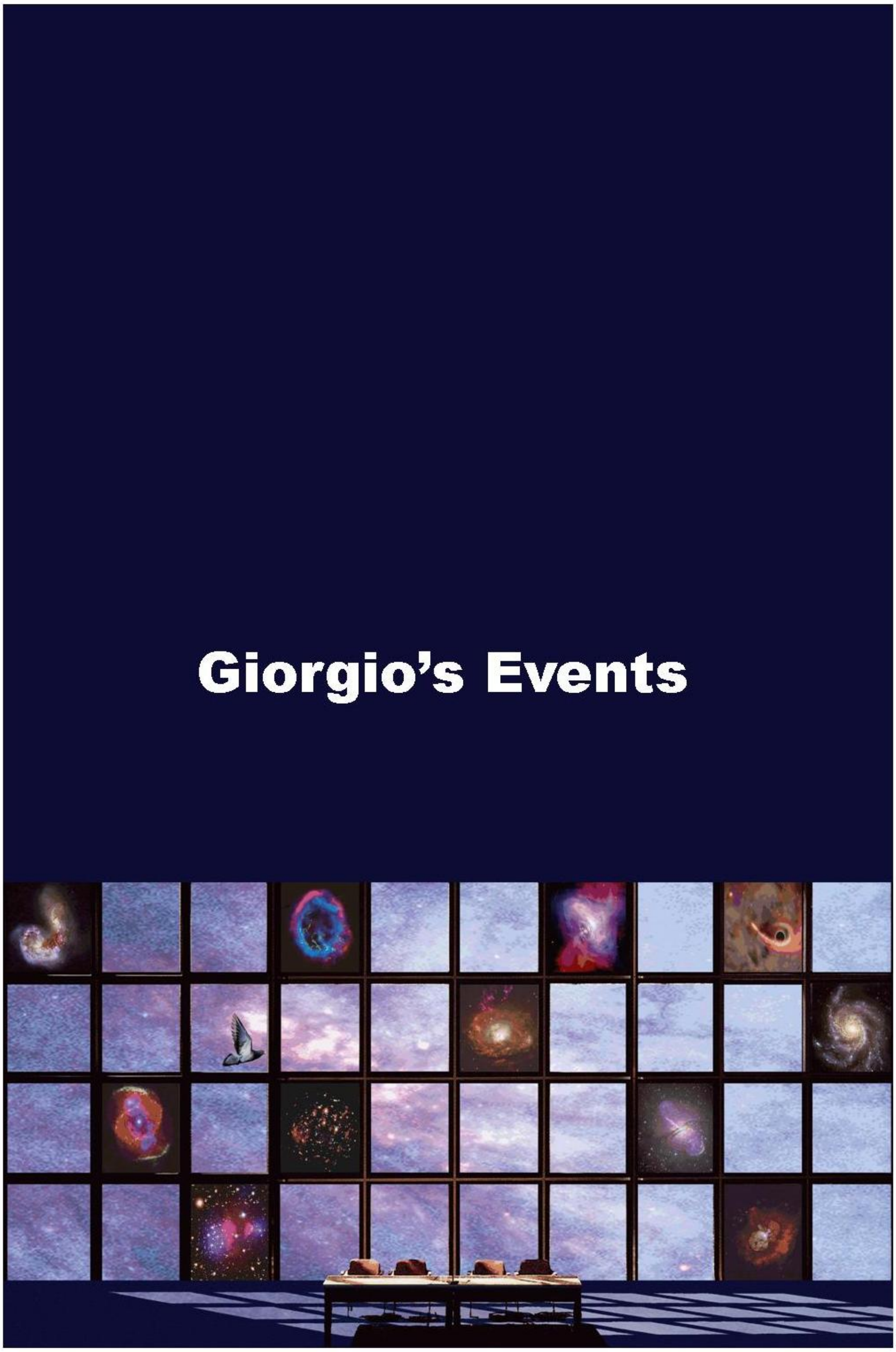
We have cross-correlated the DR5 Sloan Digital Sky Survey (SDSS) quasars with the XMM-Newton archive to obtain ~800 optically-selected quasars with X-ray observations, of which ~500 have X-ray spectra. The large sample size enables a statistical study of the relation between optical and X-ray emission, parameterized as the correlation between the optical-to-X-ray slope (alpha_ox, traditionally defined at 2 keV and 2500 Angstroms), and the optical/UV luminosity (Lopt). Optical and X-ray spectra enable a new look at this well-studied relation by defining alpha_ox at different frequencies than those traditionally used, thereby revealing clues about the underlying physics. We find that the correlation becomes significantly tighter and flatter as alpha_ox is defined further away from the peak of thermal emission (at 5000 Angstroms and 10 keV). We also find preliminary evidence suggesting that accretion rate and black hole mass may affect the efficiency of X-ray production. The physical implications of these findings will be discussed.

On the light-bending model of variability of MCG-6-30-15

P. T. Zycki[1], *K. Ebisawa*[2], *A. Niedzwiecki*[3], *T. Miyakawa*[2]

[1]Nicolaus Copernicus Astronomical Center, Warsaw, Poland
[2]The Institute of Space and Astronautical Science, Sagamihara, Japan
[3]University of Lodz, Department of Physics, Lodz, Poland

We apply the light bending model of X-ray variability to Suzaku data of the Seyfert galaxy MCG-6-30-15. We analyse the energy dependence of the root-mean-square (rms) variability and discuss conditions necessary for the model to explain the characteristic decrease of the source variability around 5-8 keV. The successful model of the rms(E) then predicts the energy spectra, which we compare to observational data. The model spectra are strongly reflection dominated and do not provide an acceptable fit to the Suzaku spectral data of the source.


Giorgio's Events

Integral, XEUS/IXO and ISS - Collaborations with Giorgio Palumbo

A. Parmar

ESA, Noordwijk (Netherlands)

Giorgio has played an immensely important role in Europe promoting high-energy astronomy to ESA and the national agencies. He has sat on innumerable ESA committees providing guidance and oversight and helping us achieve the best possible missions. I collaborated with Giorgio on just a few of these including promoting the exploitation of the ISS for science. Sadly, we failed in getting either Lobster, EUSO or e-Rosita selected for the ISS, but the rest has all been incredibly successful - witness Integral entering its 7th year of operations and XEUS, which Giorgio championed so effectively for many years, and is now reborn as the International X-ray Observatory which is a strong candidate for the first Cosmic Vision Large launch opportunity in around 2020.

The first light from MAXI onboard Japanese Experiment Module on ISS

M. Matsuoka[(1)], *and the MAXI Team*[(2)]

[(1)]JAXA, Japan Aerospace Exploration Agency, ISAS, ISS-project Office, 2-1-1 Sengen, Tsukuba, Ibaragi 305-8505, Japan
[(2)]RIKEN, Osaka Univ., Tokyo Inst. Tech., Aoyama-Gauen Univ., Nihon Univ., Kyoto Univ.

The Monitor of All-sky X-ray Image (MAXI) mission is the first astronomical payload to be installed to the Japanese Experiment Module - Exposed Facility (JEM-EF; Kibo-EF) on the ISS. MAXI has two type of X-ray slit cameras with wide field of view, GSC (Gas Slit Camera) and SSC (Solid-state Slit Camera). The X-ray detector of GSC consists of 12 pieces of gas proportional counters covering the energy range of 2 to 30 keV, while that of SSC consists of 32 pieces of X-ray CCDs covering the energy range of 0.5 to 12 keV. It is expected that the delectability of GSC is 20 mCrab for one orbit observations (~90 min) and one mCrab for one month observation.

The space shuttle, Endeavour, which carries MAXI, was delayed for launch from June to July. If Endeavour is launched in middle of July, all electronic systems of MAXI will be switched on around middle of August. Therefore, we expect that we could present some of the first light of MAXI observations in this conference. Thus we wish to call for your collaboration concerning MAXI science concerning nova-like objects, variable objects of binary X-ray sources, AGN and so on.

Gamma Ray Bursts and the High Redshift Universe

B. McBreen

University College, Dublin (Ireland)

There have been major advances in the study of GRBs in recent years because of the technological advances with telescopes in Earth orbit and on the ground. These new facilities include INTEGRAL and Swift and developments with ground based telescopes. This talk will focus on the results obtained with the new facilities and include the recent GRB at the record redshift of about 8.

Cosmic Rays with and without Giorgio Palumbo

A. Watson

University of Leeds, UK

Giorgio Palumbo studied the radio emission that occurs in the 10 – 100 MHz band when particle showers are created by high energy cosmic rays, first as a student in Canada and then in Bologna, where he used the radio telescope at Medicina for cosmic ray work. In 1975 his group showed that there were major difficulties with this technique, a conclusion that led many to desert it. I will discuss his efforts. Since then the study of ultra high energy cosmic rays has developed enormously and I will describe briefly the latest results from the Pierre Auger Observatory in Argentina where, once again, the radio technique is being explored, as it is in the LOFAR radio telescope in The Netherlands.

Giorgio and his friends

R. Della Ceca

TENTH BIRTHDAY OF CHANDRA AND XMM-NEWTON

Ten Years XMM-Newton: Scientific Achievements and Future Prospects

N. Schartel

ESA, XMM-Newton SOC, Apartado 78, 28691 Villanueva de la Cañada, Spain

XMM-Newton will celebrate its 10th anniversary in December 2009.
With about 300 refereed papers published each year, XMM-Newton is one of the most successful scientific missions of ESA ever. The talk gives an overview of the scientific highlights and achievements covering all astrophysical areas from charge exchange found in nearby comets up to the most distant clusters of galaxies. Many XMM-Newton observations address directly cosmological questions like WHIM and dark matter. Several exciting scientific perspectives for the mission's future will be discussed as well.

Ten Years of Chandra

M.C. Weisskopf

NASA MSFC – Huntsville, USA

We celebrated the 10-th anniversary of the Launch of the Chandra X-ray Observatory on July 13, 2009. During these past 10 years data, from this Great Observatory have had a profound impact on 21st century astrophysics.

With its unrivaled capability to produce sub-arcsecond images, the Observatory has enabled astronomers to make new discoveries in topics as diverse as comets and cosmology.

We shall review some of the highlights, discuss the current status, and describe future plans.

FUTURE MISSIONS

Orals

ASTRO-H and future missions in JAXA program

T. Takahashi

Institute of Space and Astronautical Science/JAXA, 3-1-1 Yoshinodai, Sagamihara, Kanagawa 229-8510, Japan

ASTRO-H, the new Japanese X-ray Astronomy Satellite following Suzaku, is an international X-ray mission, planed for launch in 2013 (JFY). It has entered into Phase B since Sep. 2008. ASTRO-H is a combination of wide band X-ray spectroscopy (3 - 80 keV) provided by focusing hard X-ray mirrors and hard X-ray imaging detectors, and high energy-resolution soft X-ray spectroscopy (0.3 - 10 keV) provided by thin-foil X-ray optics and a micro-calorimeter array. The mission will also carry an X-ray CCD camera as a focal plane detector for a soft X-ray telescope and a non-focusing soft gamma-ray detector based on a narrow-FOV semiconductor Compton Camera. With these instruments, ASTRO-H covers very wide energy range from 0.3 keV to 600 keV. The simultaneous broad band pass, coupled with high spectral resolution of ~ 7 eV by the micro-calorimeter will enable a wide variety of important science themes to be pursued. The ASTRO-H mission objectives are to study the evolution of yet-unknown obscured super massive Black Holes in Active Galactic Nuclei; trace the growth history of the largest structures in the Universe; provide insights into the behavior of material in extreme gravitational fields; trace particle acceleration structures in clusters of galaxies and SNRs; and investigate the detailed physics of jets. We will summarize the mission concept and the baseline configuration of ASTRO-H, together with the JAXA’s future plans.

e-ROSITA on SRG

P. Predehl on behalf of the eROSITA team

eROSITA (extended ROentgen Survey with an Imaging Telescope Array) will be the core instrument on the Russian Spektrum-Roentgen-Gamma (SRG) mission which is scheduled for launch in 2012. eROSITA is completely approved and funded by the German Space Agency DLR. The design driving science is the detection of 100 thousands Clusters of Galaxies up to redshifts $z > 1$ in order to study the large scale structure in the Universe and test cosmological models including the Dark Energy. This will be accomplished by an all-sky survey lasting for four years plus a phase of pointed observations on selected objects. eROSITA consists of seven Wolter-I telescope modules, each equipped with 54 Wolter-I shells having an outer diameter of 360 mm. In the focus of each mirror module, a framestore pn-CCD provides a field of view of 1° in diameter.

eROSITA is fully approved and funded by the German Space Agency DLR and Max-Planck-Society. As a recent major milestone, a “Detailed Agreement” between DLR and Roskosmos was signed on August 18, 2009. The instrument is in part (e.g., the mirror production) in phase C/D.

SRG astrophysical project

M. Pavlinsky[1], *R. Sunyaev*[1,2], *E. Churazov*[1,2], *A. Vikhlinin*[1,3], *S. Sazonov*[1], *M. Revnivtsev*[4,1], *V. Arefiev*[1], *I. Lapshov*[1], *V. Levin*[1], *V. Akimov*[1], *M. Buntov*[1], *N. Semena*[1], *S. Grigorovich*[5], *V. Babyshkin*[6], *P. Predehl*[7]

[1]IKI, Profsoyuznaya str. 84/32, Moscow, Russia
[2]MPA, Karl-Schwarzschild-Str. 1, Garching, Germany
[3]CfA, Cambridge, Massachusetts 02138, USA
[4]Excellence Cluster Universe, Technische Universität München, 85748, Garching, Germany
[5]VNIIEF, Sarov, Russia
[6]Lavochkina Association, Leningradskaya str, 24, Khimki, Russia
[7]MPE, Giessenbachstraße, Garching, Germany

The Spectrum-Roentgen-Gamma mission will be launched in the 2012 year into a L2 orbit with Soyuz launcher and Fregat buster from Baikonur. The mission will conduct the first all-sky survey with x-ray mirror telescopes eROSITA and ART-XC up to 11 keV. It will allow detection of about 100 thousand clusters of galaxies and discovery large scale Universe structure. It will also discover all obscured accreting Black Holes in nearby galaxies and many (about 3 millions) new distant AGN. Then it is planned to observe dedicated sky regions with high sensitivity and thereafter to perform follow-up pointed observations of selected sources.

Wide Field X-ray Telescope Mission (WFXT)

S. S. Murray[1]*, R. Giacconi, A. Ptak, P. Rosati, M. Weisskopf, S. Borgani, C. Jones, G. Pareschi, P.Tozzi, S. Campana,. G. Tagliaferri,. M. Bautz, and the entire WFXT Team*
(see http://wfxt.pha.jhu.edu/)

[1]Harvard-Smithsonian Center for Astrophysics

Sensitive surveys of the X-ray universe have been limited to small areas of the sky due to the intrinsically small field of view of Wolter-I X-ray optics, whose angular resolution degrades with the square of the off axis angle. High angular resolution is needed to achieve a low background per source, minimize source confusion, and distinguish point from extended objects. WFXT consists of three co-aligned wide field X-ray telescopes with a 1^{o} field of view and a <10 arc second (goal of 5 arc second) angular resolution (HEW) over the full field. Total effective area at 1 keV will be >5000 cm^2. WFXT will perform three extragalactic surveys that will cover most of the sky to 100-1000 times the sensitivity of the ROSAT All Sky Survey, >2000 deg^2 to deep Chandra or XMM-Newton sensitivity, and >100 deg^2 to the deepest Chandra sensitivity. WFXT will generate a legacy X-ray dataset of $>5x10^5$ clusters and groups of galaxies to z~2, also characterizing the physics of the intracluster gas for a significant fraction of them, thus providing an unprecedented data set for cosmological applications; it will detect $>10^7$ AGN to z>6, again obtaining spectra for a substantial fraction; it will detect $>10^5$ normal/starburst galaxies; and it will detect and characterize star formation regions across the Galaxy. WFXT is the only X-ray survey mission that will match, in area and sensitivity, the next generation of wide-area optical, IR and radio surveys.

Surveys of the Early Universe with GRBs (and Blazars?)
and obscured/dormant SMBHs with EXIST

J. Grindlay

Harvard University, Harvard-Smithsonian Center for Astrophysics

The proposed (to Astro2010) EXIST mission includes a scanning survey (2y) of a large area (4.5m^2) wide-field High Energy Telescope (HET) and sensitive Soft X-ray Imager (SXI; from Italy). GRBs imaged in HET (to <20") with ~10X the sensitivity of Swift/BAT, would trigger rapid (<200sec) followup pointings of HET, SXI and the co-aligned 1.1m cooled optical and IR telescope (IRT)IRT to measure GRB redshifts and spectra in real time to enable the first systematic in situ study of the Epoch of Reionization (EOR) and first stars and galaxies. The followup 3y pointed phase of the EXIST mission would identify and study large samples of AGN as well as Blazars (potentially at high-z), all while continueng the high-z GRB studies. EXIST would be a joint US-Italy mission with significant discovery space for a wide range of investigations. I shall describe the mission science, mission implementation, and development status.

The International X-ray Observatory

N. White [1], *H. Kunieda* [2], *A. Parmar* [3]

[1]NASA/GSFC
[2]Nagoya University
[3]ESA/ESTEC

The International X-ray Observatory (IXO), a joint ESA-JAXA-NASA effort, will address fundamental and timely questions in astrophysics: What happens close to a black hole? How did supermassive black holes grow? How does large scale structure form? What is the connection between these processes? To address these questions IXO will: trace orbits close to the event horizon of black holes, measure black hole spin for several hundred active galactic nuclei (AGN), use spectroscopy to characterize outflows and the environment of AGN during their peak activity, search for super-massive black holes out to redshift z = 10, map bulk motions and turbulence in galaxy clusters, find the missing baryons in the cosmic web using background quasars, and observe the process of cosmic feedback where black holes inject energy on galactic and intergalactic scales. IXO will employ optics with 3 sq m collecting area and 5 arc sec angular resolution - 20 times more collecting area at 1 keV than any previous X-ray observatory. Focal plane instruments will deliver a 100-fold increase in effective area for high-resolution spectroscopy, deep spectral imaging over a wide field of view, unprecedented polarimetric sensitivity, microsecond spectroscopic timing, and high count rate capability. The mission is being planned for launch in 2021 to an L2 orbit, with a five-year lifetime and consumables for 10 years. Previous experience assures us that unexpected discoveries will abound — a key feature of great observatories.

The Italian New Hard X-ray Imaging and Polarimetric Satellite Mission

G. Pareschi

INAF Osservatorio Astronomico Brera, Milano (Italy)

The New Hard X-ray Mission (NHXM, ex HEXIT-Sat), already pre-selected by ASI for the Italian Aerospace plan 2005-2010 and successfully studied in Phase A in 2008, is here presented in an improved configuration. Its concept is meant to provide a real breakthrough on a number of hot astrophysical issues, by exploiting the most advanced technology in grazing incidence mirrors and in polarimeters. Such issues, do broadly fall under two main headings: (i) Censing the black holes in the Universe and probing the physics of accretion in the most diverse conditions. (ii) Investigating the particle acceleration mechanisms at work in different contexts, and the effects of radiative transfer in highly magnetized plasmas and strong gravitational fields. NHXM is an evolution of the HEXIT-Sat concept, and will for the first time extend up to 80 keV the fine imaging capability today available only at E<10 keV, with the the further addition of photoelectric imaging polarimeter. NHXM consists of four identical mirrors, with a 10 m focal length, achieved after launch by means of a deployable structure. Three of the four telescopes will have at their focus three identical spectro-imaging cameras, while an X-ray imaging polarimeter will be placed at the focus of the fourth. In order to ensure a low and stable background, NHXM will be place on a low (600 km) Earth equatorial orbit, already used for BeppoSAX and Swift, with a launched currently planned for 2016.

FUTURE MISSIONS

Posters

Astrophysics for Students

H. Bradt

Physics Department, MIT, Cambridge MA 02139, USA

My recently published textbook, *Astrophysics Processes,* Cambridge U. Press 2008, provides a different approach to teaching fundamental physical processes underlying astronomy to upper level undergraduates or beginning graduate students. Selected fundamental topics such as Stellar structure, Equations of state, Synchrotron radiation, Dispersion and Faraday rotation, and Gravitational lensing are developed carefully and approachably from first principles. One or two examples of each process are presented also. The book stresses the physical derivations of a limited set of topics and does not attempt to present all the related astronomical lore, which is easily found elsewhere.

My previous book, *Astronomy Methods*, CUP 2004, is a physicist's guide to carrying out astronomical observations. It covers topics such as Coordinate systems, Detectors and statistics, Absorption and scattering of photons, and Astronomy beyond photons (cosmic rays, neutrinos, and gravitational waves). I sometimes say that: "It contains those basic topics you want your graduate students to know but which you do not want to bother teaching to them."

Both books will be on display at this poster.

Recent Developments in the MIRAX Mission

J. Braga, the MIRAX Team

INPE, CP 515, S. J. Campos, Brazil

The Monitor e Imageador de Raios X (MIRAX) is an X-ray astronomy satellite mission being developed at INPE, Brazil with strong international partnership. MIRAX will perform quasi-continuous imaging spectroscopy from 1 to 200 keV in a wide (58^{o} x 26^{o}) field-of-view in the central Galactic Plane with ~7 arcmin resolution. The main purpose of the mission is to study a large sample of transient sources, simultaneously, in all time-scales from seconds to several months, thus providing a very large coverage of discovery space. MIRAX observing strategy will be extremely important for the characterization of the entire history of transient phenomena on Galactic black holes and neutron stars. MIRAX will employ state-of-the art position-sensitive (0.5mm) CdZnTe (CZT) detectors and three coded-mask cameras. The total CZT detector area will be 3 x 370 cm^2. GEANT-based background simulations provide a sensitivity of a few mCrab/day at a 5σ level. The payload will be mounted on a Multi-Mission Platform satellite bus developed by INPE for a circular LEO 4-year mission at 600 km and 15^{o} inclination. The launch is preliminary scheduled for 2014. Recent developments in background and imaging simulations, camera developments and payload systems will be presented.

Potential of large X-ray spectral databases

V. Braito, M.G. Watson, S. Mateos, Y. Xu

University of Leicester, University Road, Leicester, UK

The 2XMMi catalogue provides a unprecedented database of X-ray sources serendipitously detected in pointed XMM-Newton observations and an unique opportunity to perform statistical studies of the X-ray source population as well as multi-wavelength studies of specific source classes. A key feature of the catalogue is the availability of X-ray spectra and time series data automatically extracted for the brightest 15% of the catalogue sources.

We are now further refining and optimizing the automated spectral and time series extraction procedures for the XMM catalogues with the aim of improving the reliability and quality of these data products whilst also extending the extraction to fainter X-ray sources.

We present here the first results from this new, improved approach, using several large samples of X-ray spectra for specific source classes to illustrate its power and potential to perform detailed statistical characterization studies.

Design optimization and global trade-off study of the mirror system for the *Wide Field X-ray Telescope mission*

S. Campana [(1)], *P. Conconi* [(1)], *O. Citterio*[(1)], *V. Cotroneo*[(1)], *G. Pareschi*[(1)], *G. Parodi*[(2)], *G. Tagliaferri*[(1)]

[(1)]INAF-Osservatorio Astronomico di Brera, Via E. Bianchi 46, 23807 Merate (Lc), Italy
[(2)]BCV Progetti, via S. Orsola 1, 20123 Milano, Italy

X-ray mirrors are usually built in the Wolter I (paraboloid-hyperboloid) configuration which provides, in principle, perfect on-axis images. This design exhibits no spherical aberration on-axis but suffers from field curvature, coma and astigmatism, therefore the angular resolution degrades rapidly with increasing off-axis angles. Different mirror designs exist in which the primary and secondary mirror profiles are expanded as a power series in order to increase the angular resolution at large off-axis positions (Burrows, Burgh and Giacconi, 1992, ApJ 392, 760). In this work we will present the design and the global trade-off study of an X-ray mirror systems based on polynomial optics in view of the ***"Wide Field X-ray Telescope"*** - **WFXT** – mission submitted to the *Programmatic Prioritization Panel* of the US Decadal Survey 2010 for performing an extended cosmological survey in the soft X-ray band with unprecedented flux sensitivity. It should be noted that the angular resolution required for the mission is very demanding, of 5 arcsec HEW resolution (goal) across a 1 sq.deg field of view, while an effective area of 5-9000 cm^2 at 1 keV and an energy range of 0.5-6 keV are foreseen.

Multi-wavelength Data Fusion for Astronomical Data Clustering and Analysis

S. Hojnacki[(1)], *N. Grosso*[(2)], *D. Huenemoerder*[(3)], *G. Micela*[(4)], *D. Richards*[(5)], *N. Schulz*[(3)]

[(1)]NASA/Caltech, 1200 E. California Blvd, Pasadena, California 91125, USA
[(2)]Observatoire Astronomique de Strasbourg, Université de Strasbourg, 11 rue de l'Université, 67000 Strasbourg, France
[(3)]MIT Kavli Institute for Astrophysics and Space Research, Chandra X-Ray Center, Cambridge, Massachusetts 02139, USA
[(4)]Istituto Nazionale di Astrofisica, Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, 90134 Palermo, Italy
[(5)]Penn State, 311 Thomas Building, University Park, PA 16802, USA

The nature and origin of the often variable emission from young, low-mass stars is an area of intense research. A large fraction of observing time has been devoted to the study of star formation regions and, as a result, datasets across a wide range of wavelengths exist from both ground-based and space-based observations. To take advantage of the increasing amount of multi-wavelength astronomical data, we are using data fusion techniques coupled with multivariate statistics on a large number of astronomical objects. Data fusion involves integration of heterogeneous data. This simultaneous analysis of emission across different wavelength regimes will help to provide a composite understanding of young stellar objects. A statistical clustering technique coupled with fused multi-wavelength data from the visible, X-ray, and infrared can provide insight into the physical mechanisms responsible for the intense emission from young stars in different wavelength regimes and can be used to view trends and correlations between those regimes. We present some details of data fusion and its potential problems, followed by a summary of our results thus far.

ESA Gaia and High Energy Sources

R. Hudec[(1)], *V. Simon*[(1,2)], *M. Kocka*[(1,2)], *L. Hudec*[(1,2)]

[(1)]Astronomical Institute, CZ-251 65 Ondrejov, Czech Republic
[(2)]ISDC, Versoix, Switzerland

The ESA satellite in development Gaia to be launched in 2011 will focus on highly precise astrometry of stars and all objects down to limiting magnitude 20. Albeit focusing on astrometry related matters, the satellite will also provide photometric and spectral information and hence important inputs for various branches of astrophysics.

Within the Gaia Variability UnitCU7 and related work package Specific Object Studies there has been a sub-work package accepted for optical counterparts to celestial high-energy sources, a category which includes various types of objects including the optical counterparts (i.e. optical transients and optical afterglows, including counterparts of XRFs and yet hypothetical orphan afterglows) of GRBs.

Although the sampling of photometric data will not be optimal for this type of work, the strength of Gaia in such analyses is the fine spectral resolution (spectro-photometry) which will allow the correct classification e.g. of GRB-related triggers. The possibilities to detect and to analyze optical transients and optical afterglows of GRBs as well as other types of high-energy sources by Gaia will be presented and discussed.

New Technologies for Future Space X-Ray Telescopes

R. Hudec[1,2.3]*, L. Pina, A. Inneman, V. Semencova, M. Skulinova, M. Hromcik*

(1)Astronomical Institute, CZ-251 65 Ondrejov, Czech Republic
(2)Czech Technical University, Prague, Czech Republic
(3)Rigaku Innovative Technologies Europe, Prague, Czech Republic

Future large X-ray astronomical telescopes considered by ESA and NASA require development of fully innovative technologies able to provide very high accuracy at low weight and still reasonable cost. This requires development of novel light and precise substrates. We refer of development and tests of such technologies, including precise thermal glass forming and X-ray optics based on shaped Si wafers. But also other studied approaches will be briefly mentioned, such as glassy metals and glassy carbon, as well as active optics approach both in precise shaping and control of the substrates and during manufacture process.

Astronomical X-ray Telescopes of Lobster Eye Type

R. Hudec[1,2,3]*, L. Pina, A. Inneman, V. Semencova, M. Skulinova, V. Tichy, M. Hromcik*

[1] Astronomical Institute, CZ-251 65 Ondrejov, Czech Republic
[2] Czech Technical University, Prague, Czech Republic
[3] Rigaku Innovative Technologies Europe, Prague, Czech Republic

The astronomical X-ray telescopes of Lobster-Eye (LE) type represent a promising alternative to classical X-ray telescopes which use mostly the Wolter 1 geometry. The main preference of LE is the very large field of view of order of 100 square degrees and more, in contrast to less than 1 degree in the case of conventional X-ray telescopes. The results of developments in 1990-2008 resulting in construction and tests of several test modules are briefly described and discussed, together with scientific justification.

Updating of the Electrical Ground Support Equipment of the EPIC Flight-Spare cameras

N. La Palombara, *G. Villa*

INAF – IASF Milano, Via E. Bassini 15, 20133 Milano, Italy

The EPIC instrument on-board XMM-Newton is composed by one pn and two MOS camera, which are placed at the focal plane of each XMM Mirror Module. Since the launch of the satellite, the EPIC consortium has ensured the maintenance and operation of the on-ground Flight Spare models of both cameras, in order to check on-ground possible system updates before testing them on-board; currently, they are installed at the Leicester University (UK) and at the Panter facility of the MPE at Garching (D). In both cases, the instruments are operated through the original Electrical Ground Support Equipment (EGSE), which was developed to perform the qualification and acceptance tests. Nowadays this equipment is obsolete, more than 15 years old, and it would be impossible to replace it in case of failure; moreover, in order to make easier possible tests, it is necessary to harmonize operations on the FS instruments to those performed on-board. Therefore ESA and the EPIC Collaboration have agreed to update the current EGSE by replacing its man-machine interfaces with a system based on SCOS2000, the same used by ESOC for the on-board operation. Here we show the proposed solution and report on the current status of this activity.

MAXI Nova Alert System and Latest Scientific Results

H. Negoro, S. Miyoshi, R. Ishiwata, H. Ozawa[1]*, M. Matsuoka, K. Kawasaki, S. Ueno, H. Tomida, H. Kohama, M. Suzuki, M. Ishikawa*[2]*, T. Mihara, M. Sugizaki, Y. Nakagawa*[3]*, H. Tsunemi, E. Miyata*[4]*, N. Kawai, M. Morii*[5]*, A. Yoshida, K. Yamaoka*[6]*, M. Nakajima*[7]*, Y. Ueda, S. Eguchi*[8]

[1]Nihon University, CST, 1-8 Kanda Surugadai Chiyoda, Tokyo, Japan
[2]JAXA
[3]RIKEN
[4]Osaka University
[5]Tokyo Institute of Technology
[6]Aoyama University
[7]Nihon University
[8]Kyoto University

MAXI, Monitor of All-sky X-ray Image, is the first astronomical telescope onboard the ISS. One of the main goals of our mission is to discover new transient objects, such as X-ray novae, γ-ray bursts, and unseen high-energy objects with wide fields of view of two types of X-ray cameras, Gas Slit Camera (GSC) and Solid-state Slit Camera (SSC). (see, Matsuoka et al. in this volume).

We have developed completely new data analysis systems to find transient objects and send alert to the world as soon as possible. Here we present the introduction of the nova alert systems and the latest scientific results in ~2 months after the launch! An expected discovery rate of "new" X-ray novae with MAXI is optimistically 5-10 times higher than before, so that one or two new such objects are expected to be discovered.

A lightweight, low-power and sensitive Silicon-based All Sky Monitor for transient sources and Gamma Ray Bursts

R. Campana, *L. Pacciani* *et al.*

INAF/IASF-Roma, Via Fosso del Cavaliere 100, 00133 Roma, Italy

The X-ray universe has an high level of variability: a continuous monitoring of a large fraction of the sky is thus essential to detect the outbursts of Galactic and extragalactic sources, to study their evolution and to allow a rapid follow-up with observatories with a higher sensitivity and better angular and spectral resolution, but with a restricted field of view. Moreover, the long-term monitoring allows also to study the secular flux and spectral evolution of these sources.

We present here a concept for a coded-mask All Sky Monitor based on Silicon Drift detectors. The current design has a high level of readiness, minimizes the total weight (<10 kg for each 1-D module with a sensitive area of ~500 cm^2) and power consumption (<10 W per module), has a sensitivity in the range 3-60 keV, a fully coded field of view of >2 steradians and an on-axis sensitivity of ~3 mCrab (5 σ, 50 ks).

Moreover, the intrinsic modularity of the detector allows to envisage experiments with much larger effective area.

We show here the expected scientific performances of such an experiment, with emphasis on the observations of X-ray Galactic transients and gamma-ray bursts.

In flight Calibration of the 2D XMM-Newton Point-Spread function: Impact on source detection

J. Ramirez[(1)], *A. Read*[(2)], *G. Lamer*[(1)], *R. Saxton*[(3)] *and A. Schwope*[(1)]

[(1)]Astrophysikalisches Institut Potsdam, An der Sternwarte 16, 14482 Potsdam, Germany
[(2)]Department of Physics and Astronomy, University of Leicester, University Road, Leicester, UK
[(3)]XMM SOC, ESAC, Apartado 78, 28691 Villanueva de la Cañada, Madrid, Spain

We present results on the performance of a new 2D XMM-Newton Point-Spread function (Psf) model in source detection. The model takes into account the intrinsic ellipticity seen in point-like sources at large off-axis angles in addition to the spikes produced by the supporting structure of the telescope. We investigate the performance of this model on detection of spurious sources, sensitivity, computation of fluxes in different X-ray bands, and relevant source parameters. Preliminary results indicate a significant reduction on the detection of spurious sources close to bright sources. We expect this model to impact positively on the creation of future XMM-Newton catalogues.

Simulations of X-Ray Telescopes for eROSITA and IXO

C. Schmid[1], *M. Martin*[2], *J. Wilms*[1], *I. Kreykenbohm*[1], *E. Kendziorra*[2], *D. Barret*[3], *M. Mühlegger*[4]

[1]Friedrich-Alexander-University of Erlangen-Nuremberg, Sternwartstraße 7, D-96049 Bamberg, Germany
[2]Institute for Astronomy and Astrophysics Tübingen, Sand 1, D-72076 Tübingen, Germany
[3]Centre d'Etude Spatiale des Rayonnements de Toulouse, 9, av du Colonel Roche, Toulouse, France
[4]Max Planck Institute for Extraterrestrial Physics, Giessenbachstraße, D-85748 Garching, Germany

We report on the development of a generic X-ray instrument simulator to be used in simulations of future X-ray missions. Based on a Monte Carlo approach, the code generates photon events for sources in an X-ray source catalog such as the ROSAT all sky survey or the XMM-Newton slew surveys and then models the imaging and detection process based on the available calibration files (e.g., point spread functions for the imaging). The output of the program are event lists which can be analyzed using standard software such as xselect. Due to its modular concept the simulation can be easily adapted to different concepts of imaging detectors.

As examples for the potential use of the simulation we present results of simulations of the detector performance for the High Time Resolution Spectrometer and the Wide Field Imager on the International X-ray Observatory.

IACHEC: International Astronomical Consortium for High Energy Calibration

S. Sembay, on behalf of the IACHEC consortium

University of Leicester, Leicester, LE1 7RH, UK

The IACHEC aims to provide standards for high energy calibration and supervise cross calibration between different X-ray and Gamma-ray missions. This goal is reached through working groups, where IACHEC members cooperate to define calibration standards and procedures. The scope of these groups is primarily a practical one: a set of data and results will be the outcome of a coordinated and standardized analysis of references sources ("high-energy standard candles"). Past, present and future high-energy mission can use these results as a calibration reference. Calibration scientists from XMM-Newton, Chandra, Suzaku, Swift, Integral and RXTE have so far contributed to the activities of the IACHEC to the benefit of our knowledge of the calibration uncertainties in each mission. We describe here some of the results that have arisen from the IACHEC with a focus on the cross-calibration analysis of targets such as the thermal SNR 1E0102.2-7219, the non-thermal SNR G21.5-0.9, the isolated neutron star RX J1856.5-3754 and the Blazar, PKS 2155-304.

UltraPhot project: a multi-fiber high-speed photometer on VLT

F. Roques[1], *I. Guinouard*[2], *H.K. Chang*[3], *A. Kong*[3], *S.P. Lai*[3], *I C. Shih*[1,3], *A. Doressoundiram*[1], *B. Sicardy*[1], *D. de Martino*[4], *R. Silvotti*[4], *J.P. Beaulieu*[5], *J. Schneider*[6], *J.T. Buey*[1], *M. Marteaud*[1], *D. Horville*[2], *T. Farrell*[7], *K. Shortridge*[7]

[1]LESIA, Paris Observatory, Meudon, France
[2]GEPI, Paris Observatory, Meudon, France
[3]Institute of Astronomy, National Tsing-Hua University, Hsin-Chu, Taiwan
[4]INAF, Naples Observatory, Italy
[5]Institut d'Astrophysique de Paris (IAP), France
[6]Luth-Paris Observatory, France
[7]Anglo-Australian Observatory, Australia

We introduce the MEFOS-Ultrophot project jointed by the Paris Observatory, France and the National Tsing-Hua University, Taiwan. Ultraphot is a multi-fiber high-speed photometer to be mounted on the 8-m UT2 (Kueyen) of the European Southern Observatory's (ESO) Very Large Telescope (VLT) at Cerro Panaral, Chile. Ultraphot will provide simultaneous observation of multiple targets in large field of view, and high time resolution photometry which is required by various studies, such as close binaries, young stellar object, and TNO occultation etc.. A test model, MEFOS, has been mounted this year on the 193-cm telescope at the Observatory of Haute-Provence (OHP), in Southern France.

Astrosat – The Multiwavelength Indian Astronomy Satellite

G. Stewart for the Astrosat Team

University of Leicester, University Road, Leicester, LE1 7RH, UK

The Indian Astrononomy satellite, ASTROSAT, is set for launch in 2010. Astrosat will provide an unprecedented multi-wavelength capability from the optical to hard X-rays. Details of the instrumentation, expected performance and likely science drivers will be discussed.

High Energy Multi Mission Science and the European Virtual Observatory

J.A. Tedds[(1)], M.G. Watson[(1)], D. Law-Green[(1)], C. Page[(1)], C. Mountford[(2)], J. Osborne[(2)], C. Motch[(3)], L. Michel[(3)], M.T. Ceballos[(4)], F.J. Carrera[(4)], C. Arviset[(5)], P. Osuna[(5)] and the European Virtual Observatory

[(1)]XMM-Newton Survey Science Centre, Dept of Physics & Astronomy, University of Leicester, UK
[(2)]UK Swift Data Centre, Dept of Physics & Astronomy, University of Leicester, UK
[(3)]OAS Strasbourg, France
[(4)]IFCA (CSIC-UC), Spain
[(5)]ESAC, Spain

High energy archive data centres have been at the forefront of new developments in publishing multi mission datasets to the Virtual Observatory (VO) in order to allow seamless cross correlation and improved multi wavelength science capability. We highlight the role of the European VO in coordinating assistance to publish datasets to the VO with examples from the XMM-Newton Survey Science Centre (SSC) including the 2XMMi catalogue and other ESA and NASA missions including the new Chandra Source Catalogue along with correlations to large area sky surveys at other energies such as UKIDSS, 2MASS and SDSS. We demonstrate how single or multiple VO published datasets can be searched, queried, visualised and cross matched in one shot to improve visibility and enable wider science exploitation of your survey results. An example is the ability to run python science scripts against over 500 catalogue datasets simultaneously in the Leicester high Energy Data Archive System (LEDAS) and any other VO enabled archives using the VO Desktop suite provided by the UK VO Technology Centre project. We describe multi wavelength science use examples now routinely possible including use of XMM-SSC optical spectra of X-ray survey counterparts, extraction of upper flux limits for any position observed by XMM-Newton where no catalogued source is recorded and new Swift GRB catalogue search capabilities.

CONCLUSIONS

The Future of X-Ray Astronomy: What's Past is Prologue

M. Urry

Yale University, United States

X-ray astronomy began nearly 50 years ago with a couple of brief but paradigm-shifting rocket flights and has today culminated in world-class observatories like Chandra, XMM-Newton, Suzaku, Swift, INTEGRAL, ... Discoveries at X-ray energies have proved essential to understanding our Universe, and X-rays are at the center of almost every astrophysical question for the future. During the past 30 years, access to X-ray observatories has been more or less continuous for citizens across the world, and this capability promises to continue indefinitely into the future – which makes it all the more surprising that some universities, perhaps out of concern for the transient nature of these observatories, hesitate to hire permanent faculty whose research centers on X-rays. That hiccup aside, the future of X-ray astronomy is bright provided we continue to devote talent and resources to technology development.

Concluding Remarks

A. Fabian

University of Cambridge, Institute of Astronomy, Cambridge, UK

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