BLACK HOLE UNIVERSE 2012

BAMBERG, GERMANY, 18-22 JUNE 2012

Program & Abstracts

SPECIFIC TOPICS INCLUDE:

IN- AND OUTFLOWS: THEORY AND OBSERVATIONS
RELATIVITY AND BLACK HOLES: IRON LINES AND GRAVITATIONAL WAVES
POPULATIONS, FORMATION AND EVOLUTION OF BLACK HOLES
FUTURE OBSERVATIONAL NEEDS AND THEORETICAL CHALLENGES

INVITED SPEAKERS INCLUDE:

T. BOGDANOVIC, L. BRENNEMAN,
J. DEXTER, C. FRYER, R. HICKOX,
J. MCKINNEY, J. NEILSEN,
M. A. NOWAK, F. PANESSA

SCIENTIFIC ORGANIZING COMMITTEE

T. BELLONI, L. BURDERI, S. CORBEL,
T. DI SALVO, E. KALEMCI,
S. MARKOFF (CO-CHAIR),
I. MCHARDY, J. RODRIGUEZ,
P. UTTLEY, R. WIJNANDS,
J. WILMS (CHAIR)
T. MACCARONE

LOCAL ORGANIZING COMMITTEE

E. DAY, R. DURO, V. GRINBERG, I. KREYKENBOHM,
M. KUEHNEL, I. MISKOVICOVA,
J. WILMS (CHAIR)

WEB: WWW.BLACK-HOLE.EU/BHU2012 **EMAIL:** BHU2012@BLACK-HOLE.EU

Black Hole Universe

POSTER BY ILARIA PAROLIN - IP.ASTROGRAPHIC@GMAIL.COM

Program and Abstracts

Black Hole Universe

Black Hole Universe

Monday

Monday – 10:20–11:00

Chris Fryer — Los Alamos National Laboratory, USA

Supernovae, GRBs and the formation of Black Holes

The nature of black hole formation is closely linked with explosions from stellar collapse. I will review the current explosion mechanisms for supernovae and gamma-ray bursts and describe how we use our understanding of these mechanisms to determine the formation processes behind black hole formation. Understanding the black hole formation process allows us to predict black hole mass and kick distributions and I will present the latest work in these studies.

Monday – 11:00–11:20

Michela Mapelli (*presenter:* E. Ripamonti) — INAF-Padova Astronomical Observatory, Italy

Massive stellar black holes from stellar evolution and dynamics

Stellar black holes (SBHs) form from the collapse of massive stars. The mass of SBHs is currently thought to be in the 3–20 solar mass ($M_\odot$) range, but this is highly uncertain: recent observations indicate the existence of at least one SBH with mass $> 20\,M_\odot$. Stellar metallicity and dynamical processes are two key ingredients to shape the mass spectrum of SBHs. Dynamical interactions influence the mass of SBHs, as they trigger mass transfer and mergers between stars and between stars and SBHs. The metallicity of the progenitor star strongly influences the mass of the remnant, as only metal-poor stars can have final masses larger than $\sim 40\,M_\odot$ and are expected to directly collapse into SBHs with mass $>25\,M_\odot$. In this talk, I discuss the formation and evolution of massive SBHs (MSBHs), with mass ranging from 25 to $\sim 80\,M_\odot$. I study the effects of MSBHs on the population of X-ray sources and on the dynamics of star clusters.

Black Hole Universe

Monday – 11:40–12:00

Jonathan C. McKinney Stanford, USA

Simulating Extreme Black Hole Engines

The standard well-accepted behavior of black hole accretion disks is that of an MRI-driven MHD turbulent disk with a large-scale jet being produced when the field near the hole is dipolar. However, most prior MHD simulations have used initial conditions that artificially limited the magnetic flux near the black hole. We use fully 3D GRMHD simulations to show that accumulation of magnetic flux naturally leads to a saturated state with qualitative changes in both the disk accretion flow and jet. Our results suggest that the accumulation of ordered magnetic flux is an important parameter in controlling the accretion disk state and the production of jets and quasi-periodic oscillations.

Monday – 12:20–12:40

Renaud Belmont IRAP, France

Stochastic acceleration in accreting black holes.

The hard X-ray emission of accreting black holes is thought to originate very close to the central compact object, in a corona, or at the base of the jet. It traces high energy particles, i.e., for instance in X-ray binaries, leptons from about 10 keV to several MeV. Although this is now well established, the precise mechanism accelerating leptons to such high energies is still uncertain. Whether it is based on collisions with hot protons, magnetic reconnection, shock acceleration or 2^{nd} order Fermi process, very little work has been done so far to model the microphysics of acceleration in black hole systems and to test it against observations.

I will present recent results on second order Fermi acceleration in high energy plasmas. This acceleration process results stochastically from the resonant interaction of particles with plasma waves. To investigate its properties and efficiency we solved numerically the evolution of a hot gas constituted by several species: protons, leptons, photons and waves interacting with each others through radiative processes, Coulomb collisions, and resonant wave-particle interactions. We find that the stochastic acceleration of leptons is controlled by the proton temperature. In conditions typical of the corona of X-ray binaries, it can be very efficient in accelerating leptons and producing hard X-ray emission. Finally, the spectral states of X-ray binaries can be reproduced accurately using this first self-consistent modeling of an acceleration mechanism.

Monday – 12:40–13:00

Christiaan Brinkerink Radboud University Nijmegen, the Netherlands

Jet launching at small radii: results from 2d axisymmetric simulation

Using the HARM2d code I have looked more closely at what happens in the vicinity of a black hole surrounded by an optically thin radiatively inefficient accretion flow. The differences in flow parameters between the jet spine and jet sheath are appreciable, and this has consequences for the expected radio emission spectrum from these regions. The tracks covered by tracer particles in the flow provide some insight into the circumstances under which gas gets accelerated in the jet boundary, helping us to better predict the synchrotron spectra that may be associated with the jet launching region.

Monday – 14:35–14:55

Himadri Ghosh S. N. Bose National Centre for Basic Sciences, India

Numerical Studies of the Hydrodynamic, Spectral and Timing Properties of a Two-Component Accretion Flow around a Black Hole

(Abbreviated) We carry out a time dependent numerical simulation where both the hydrodynamics and the radiative transfer are coupled together. We consider a two-component accretion flow in which a Keplerian disc is immersed inside an accreting low angular momentum flow (halo) around a black hole. The injected soft photons from the disc are reprocessed by electrons in the halo. In presence of an axisymmetric soft photon source the spherically symmetric Bondi flow loses its symmetry and becomes axisymmetric but nonspherical. Using the Monte Carlo method, we generated the radiated spectra as a function of the accretion rate, $\dot{M}$. The transition from a hard state to a soft state is determined by the $\dot{M}$ of the disc and the halo. We separate out the signature of the bulk motion Comptonization and discuss its significance. We study how the net spectrum is contributed by photons suffering different number of scatterings and spending different amounts of time inside the Compton cloud.
The accretion flow with angular momentum was observed to slow down close to the axis and formed a shock or boundary layer. This layer is produced primarily due to the centrifugal barrier that the accretion flow experiences. We keep the inner edge of the Keplerian disk at the shock location when we carry out the time-dependent coupled hydrodynamics and the radiative transfer simulation. We find that Quasi-periodic oscillations (QPOs) are primarily due to the oscillations of this layer. We show that the observational quantities like spectral slope, hard photon count etc. give the same QPO frequencies as the frequency with which the shock location or the boundary layer is oscillating.

Monday – 14:55–15:15

Viacheslav Zhuravlev Sternberg Astronomical Institute, Russia

Relativistic twisted accretion disc around a Kerr black hole

Accretion discs around the rotating black holes are ubiquitous in the Universe. In general case, when disc is misaligned with respect to the equatorial plane of the black hole, it takes a twisted shape. Theoretical studies of twisted discs started from the paper by Bardeen & Petterson in 1975. In present work an analytical study of twisted accretion disc has been carried out in the full relativistic approach, for the first time. We derive equations describing dynamics of a thin disc around a slowly rotating black hole and analyze the shapes of stationary twisted configurations. It is shown that stationary disc behaves differently depending on the value of the viscosity parameter and the well-known Bardeen-Petterson effect when the fluid motion aligns with the equatorial plane of the black hole takes place for sufficienly thin and viscid discs only.
Our results may have implications for determining structure and variability of accretion discs close to its inner radii as well as for modelling of emission spectra coming from different sources, which are supposed to contain black holes.

Monday – 15:15–15:35

Stéphane Corbel University Paris Diderot & CEA Saclay, France

On the formation and destruction of self-absorbed compact jets in accreting binary black holes

Weakly accreting black holes have been the focus of many recent studies due to the presence of several emission processes that are very difficult to disentangle in this regime. Particularly, these recent years demonstrated the presence of powerful compact jets in the hard state with emission ranging from radio up to near-infrared frequencies and possibly also a contribution at high energy. In this talk, I will highlight the rarely observed periods of destruction and formation of compact jets, based on a series of new multi-wavelength observations (including the upgraded ATCA and Herschel for the first time) of the recurrent black hole GX 339−4 (amongst others). A generic picture of their formation and destruction will be presented, in light of recent theoretical developments.

Monday – 15:35–15:55

Arman Tursunov National University of Uzbekistan, Uzbekistan

Acceleration of particles by black hole with gravitomagnetic charge immersed in magnetic field

The electromagnetic field around nonrotating black hole with nonvanishing gravitomagnetic charge immersed in external asymptotically uniform magnetic field have been considered. Charged particle motion has been studied using the Hamilton-Jacobi equation. The particle acceleration mechanism and particle collisions mechanisms have been studied. It was shown that presence of the gravitomagnetic charge increase the maximal value of the center of mass energy.

Monday – 16:25–17:05

Michael Nowak MIT-Kavli Institute, USA

Spins and Winds: A Modern (and not so Modern) History of Black Hole X-ray Binaries

In this talk, I present a (brief and biased) overview of some of the most interesting current areas of study with black hole X-ray binaries. Much recent research has focused on whether or not we can use observations to measure fundamental properties of black holes, namely the black hole spin. Two independent methods have been discussed in the literature: relativistically broadened iron lines, and disk continuum methods. I give an overview of some of the recent results with both of these methods. Whether either method works in practice is reliant upon our still incomplete understanding of accretion geometry as well as of the emission mechanisms in accreting systems. Both of these issues harken back to the very beginnings of the theory of accretion flow and its stability. I discuss some of the ideas still with us from these early theoretical studies and how they continue to influence our current thinking. I also discuss those ideas still absent from theoretical treatments, but that are becoming increasingly prominent from observational studies. Specifically, the presence of jets in X-ray spectrally hard states is something that has been recognized as extremely important for the past 15 years. In addition to jets, we are now just beginning to appreciate the importance of winds as well. Whereas winds in black hole X-ray binary systems also have been known for over 15 years, we are just beginning to come to an observational understanding of where they lie in relationship to the outburst cycle of a “typical” black hole X-ray transient.

Monday – 17:05–17:25

Victoria Grinberg Dr. Remeis-Observatory & ECAP, Germany

Every second week for fourteen years: *RXTE* observations of Cyg X-1

RXTE has observed the high mass X-ray binary Cyg X-1 at least biweekly from 1998 to the end of the mission in 2011 and allowed us to assemble a unique dataset of this persistent yet highly variable source. Most of these observations were simultaneously covered in radio. We review results obtained from this dataset over the years, which have considerably increased our knowledge of the properties of the hard state and of state transitions of Galactic black hole X-ray binaries in general: for example the consistent phenomenological description of the energy and power spectra with only a few variable components, the occurrence of (enhanced) time lags and (failed) state transitions, the presence of the rms-flux correlation in all states, the long term correlations between the X-ray and radio emission and a very fast state transition. We also present the most recent analysis of all the data on Cyg X-1 obtained by *RXTE* during its lifetime, which includes, among others, a reference mapping of states onto the data from all sky monitors such as ASM, BAT and MAXI.

Monday – 17:25–17:45

Elise Egron Universitá degli Studi di Cagliari, Italy

Self-consistent study of the reflection component in 4U 1705−44 with *XMM-Newton*, *BeppoSAX* and *RXTE* in the hard and soft state

We use data of the bright atoll source 4U 1705−44 taken with *XMM-Newton*, *BeppoSAX* and *RXTE* both in the hard and in the soft state to perform a self-consistent study of the reflection component in this source. The data from these X-ray observatories are not simultaneous. Nevertheless, the spectral properties of the source are very similar at similar flux levels. We therefore select observations performed at similar flux levels in the hard and soft state in order to study the spectral shape in these two states in a broad band (0.1–200 keV) energy range, with good energy resolution, and using self-consistent reflection models. These reflection models provide a good fit of the X-ray spectrum both in the hard and in the soft state in the whole spectral range. We discuss the differences in the main spectral parameters we find in the hard and the soft state, respectively, providing evidence that the inner accretion disk is truncated further from the compact object in the hard state.

Tuesday

Tuesday – 09:40–10:20

Joey Neilsen MIT Kavli Institute, USA

New Results on Massive Winds in Black Hole X-ray Binaries

In the last decade, high-resolution X-ray spectroscopy has revolutionized our understanding of the role of accretion disk winds in black hole X-ray binaries. Carrying away as much as $25\times$ more matter than reaches the black hole, these ubiquitous, highly ionized outflows exert a powerful influence on the dynamics of the accretion flow: they may quench relativistic jets and may facilitate or even cause state transitions. I will review a few major developments from the last decade, and then I will present some brand new results from our multiwavelength observing campaigns on several X-ray binaries, which reveal some of the deepest iron absorption lines ever observed with *Chandra*, as well as some of the fastest line variability. Highlighting in particular the intricate links between the inner accretion flow, relativistic jets, and accretion disk winds, I will demonstrate how new *Chandra* observations continue to inform our understanding of black hole accretion states.

Tuesday – 10:20–10:40

Ivica Miskovicova Dr. Remeis Observatory & ECAP, Germany

Feeding the monster: Wind accretion in Cygnus X-1

The accretion onto the black hole in the HMXB Cygnus X-1 is powered by the strong line-driven wind of its O type companion HDE226868. The wind is highly structured: clumps of lower ionization stages and temperatures, originating from large density and temperature inhomogeneities, are embedded in highly photoionized material. Due to the strong tidal interactions in the system, the wind is focused along the binary axis, resulting in its variations over the orbital phase. We present results of the detailed analysis of the stellar wind in the hard state of Cygnus X-1 from high-resolution *Chandra*-HETGS observations at four distinct orbital phases: $\phi \sim 0$, $\sim$0.2, $\sim$0.5 and $\sim$0.75. All light curves but the one at $\phi \sim 0.5$ show strong absorption dips that are believed to be caused by the clumps in the wind. We compare the spectral properties between dips and persistent flux: while the H-like and He-like absorption lines reveal the highly photoionized wind, the lines of lower ionization stages visible only in the dip spectra constrain the properties of the clumps. Comparison between different orbital phases allows us to study the complex structure and dynamics of the wind.

Tuesday – 10:40–11:00

Diego Altamirano Sterrenkundig Instituut “A. Pannekoek”, Amsterdam, The Netherlands

IGR J17091−3624: learning from the little sister of GRS 1915+105

IGR J17091−3624 is a black hole system which has very recently attracted the interest in the scientific community as it is the first system to show some of the bizarre, high-amplitude, highly- structured X-ray variability only seen before in the extremely energetic black hole system GRS 1915+105. In comparable states, IGR J17091−3624 X-ray flux can be between 30 and 50 times lower than that measured from GRS 1915+105, implying that either (i) all models requiring near Eddington luminosities for GRS 1915+105-like variability fail, (ii) IGR J17091−3624 is very far ($>$20 kpc) or (iii) IGR J17091−3624 harbors one of the least massive ($< 3M_{\odot}$) black holes known. In this talk I will review what we have learned so far from the comparison between IGR J17091−3624 and GRS 1915+105 and discuss the prospects for gaining a better understanding of what happens at the brink of a black hole.

Tuesday – 11:40–12:00

Tolga Dincer Sabancı University, Turkey

X-ray, optical and infrared observations of GX 339-4 in 2011 decay

In this talk we present multiwavelength observations of the black hole transient GX 339−4 during its outburst decay in 2011 using the data from *RXTE*, *Swift* and SMARTS. Based on the X-ray spectral, temporal, and the optical/infrared (OIR) properties, the source evolved from intermediate to low/hard state. Twelve days after the transition to the low/hard state, a rebrightening was observed simultaneously in the optical and the infrared bands. Spectral energy distributions of the excess OIR emission from the start of the rebrightening, and close to the peak of the rebrightening yield a flat spectral slope. Assuming that the excess is from a compact jet, we discuss the possible locations of the spectral break that mark the transition from optically thick to optically thin synchrotron components. Only during the rising part of the rebrightening, we detected fluctuations with the binary period of the system. We discuss a scenario that includes irradiation of the disk in the intermediate state, irradiation of the secondary star during OIR rise and jet emission dominating during the peak to explain the entire evolution of the OIR light curve.

Black Hole Universe

Tuesday – 12:00–12:20

Pierre-Olivier Petrucci Institut de Planétologie et d'Astrophysique de Grenoble, France

Disc apparent recession and jet reappearance: the turning back of GX 339−4 in the hard state at the end of its 2010–2011 outburst

We triggered our Suzaku ToO (5×20 ks spaced by a few days) at the very end of the 2010/2011 outburst of GX 339−4, when the source is turning back in the hard state and the visibility window becomes possible. Quasi-simultaneous radio observation were also carried on. Although at almost the end of the transition, we had the opportunity to follow, in the radio and X-rays, the onset of the jet reappearance. We caught indeed the switching on of the radio emission (and the radio spectrum becoming inverted) between the first two Suzaku pointings. From an X-ray point of view, the first two observations show an excess at low energy well fitted by a multicolor disc extended down to the last stable orbit. Thus the disc could exist down to the last stable orbit until the very end of the transition, where the source begins to become very faint. Interestingly, the inner disc radius becomes larger than $10R_{\rm g}$ (best fit value of $90R_{\rm g}$) in the third observation suggesting the beginning of the disc recession but a few days after the switching on of the radio emission. We will present our results in this talk and the constrains we can put on the disc apparent recession and its link to the jet reappearance.

Tuesday – 12:20–12:40

Arash Bodaghee UC Berkeley, USA

***Fermi*-LAT observations of microquasars**

The accreting black holes in microquasars are considered to be scaled-down versions of active galactic nuclei since both share similar emission processes and radio jets. While their larger brethren are easily detected in the gamma-rays constituting a large fraction of the 2FGL catalog, only one microquasar has been unambiguously detected above $\sim$100 MeV: Cygnus X-3. In this talk, we present our results from *Fermi*-LAT observations of Cygnus X-3. Using multi-wavelength data, we illustrate the sequence of events before and after the May 2010 gamma-ray flare which suggests that IC scattering is not the only mechanism that can produce gamma-rays in this source. Then, we extend this analysis to search for gamma-ray emission from other microquasars such as Cygnus X-1 and GRS 1915+105. Analysis of the first 3 years worth of *Fermi* data on these sources indicates no significant detections ($> 4\sigma$) on a 1, 3, 5, or 10-day timescale. We close by discussing the implications of the non-detections, including preliminary results from orbital-phase folded light curves, and the possibilities to improve the sensitivity by employing a photon-weighting method.

Black Hole Universe

Tuesday – 12:40–13:00

Henric Krawczynski Washington University in St. Louis, USA

The X-ray Polarimetry Mission *GEMS* and Tests of Accretion Disk Models and Strong Gravity General Relativity

The NASA mission *GEMS* (Gravity and Extreme Magnetism SMEX) scheduled for launch in 2014 will enable very sensitive X-ray spectropolarimetric observations of black holes in X-ray binaries. In this contribution, we will discuss the *GEMS* black hole science program, and the prospects of using *GEMS* for tests of General Relativity (GR) in the strong gravity regime. Assuming that GR is correct, *GEMS* will be able to perform sensitive tests of accretion disk models and to constrain the spins of the observed black holes. Our discussion of GR tests with *GEMS* is based on ray tracing simulations that use the Kerr metric and the family of non-GR metrics proposed by Johannsen & Psaltis (2012). We discuss practical difficulties to distinguish GR from non-GR models arising from the contamination of the thermal accretion disk emission by the corona and reflection emission components.

Tuesday – 14:35–14:55

Sebastian Heinz University of Wisconsin-Madison, USA

Inflow, outflow, all about flow

I will discuss the interaction of jets from X-ray binaries with the circum-binary material, focusing on interaction in dynamic environments: head-winds due to the binary's proper motion through the ISM and interaction with winds from the companion star. Numerical simulations show that the observational signatures of this interaction can provide powerful constraints on jet physics and environment, and, consequently, that this interaction can have a significant impact on the structure and evolution of the jets themselves.

Black Hole Universe

Tuesday – 14:55–15:15

Tomaso Belloni INAF - Osservatorio Astronomico di Brera, UK

High-frequency Quasi-Periodic Oscillations from Black Hole Binaries: the *RossiXTE* Legacy

Sixteen years of observations of black-hole binaries with the Rossi X-Ray Timing Explorer have given us a large database which will be unequalled for many years. Despite the large number of observations, only a handful of them allowed the detection of high-frequency (> 30 Hz) features in the Power Density Spectra. These signals are thought to be directly connected to the effects of General Relativity in the strong field regime. I will present the results of a systematic analysis of the full archive and review the main properties of the existing significant signals.

Tuesday – 15:15–15:35

Teo Muñoz-Darias University of Southampton, UK

A new look at the outburst evolution of black hole X-ray binaries

X-ray observations performed during the last decades by several missions have provided a large data base on galactic black hole X-ray binaries. I will present some novel tools that are contributing to a better understanding of its outburst evolution, and I will review the common features observed. Finally, I will focus on the influence that the orbital inclination has in the timing and spectral properties and what new information can be extracted by comparing systems observed from different line-of-sights.

Black Hole Universe

Tuesday – 15:35–15:55

Adam Ingram Durham University, UK

A unique test for a relativistic precession origin of the low frequency QPO in X-ray binaries

Low frequency quasi-periodic oscillations (QPOs) seen in many black hole and neutron star binaries have the potential to be very powerful diagnostics of the inner accretion flow. However, this potential cannot be realised without a quantitative model for the QPO. It has recently been shown that the same truncated disc/hot inner flow geometry which is used to interpret the spectral transitions can also directly produce the QPO from Lense-Thirring (vertical) precession of the hot inner flow. This correctly predicts both the frequency and spectrum of the QPO, and the tight correlation of these properties with the total spectrum of the source via a changing truncation radius between the disc and hot flow. These successes already make the model very attractive, but here I show that it gives a unique prediction in its iron line signature. A tilted flow illuminates different azimuths of the disc as it precesses. The iron line arising from this rotating illumination is blue shifted when the flow irradiates the approaching region of the spinning disc and red shifted when the flow irradiates the receding region of the disc. This gives rise to a characteristic rocking of the iron line on the QPO frequency which is a necessary and sufficient test of a Lense-Thirring origin. I show that it may be possible to observe this effect using data from *RXTE* or *XMM-Newton* but future mission which combine large effective area and moderate spectral resolution (Athena WFI and especially *LOFT* LAD) will be able to measure this with precision. A significant detection of this effect would constitute definitive evidence for the Lense-Thirring model, thus solving the $\sim$25 year mystery of low frequency QPOs and confirming a fundamental prediction of general relativity after some 90 years.

Tuesday – 16:25–16:45

Maithili Kalamkar Sterrenkundig Instituut “A. Pannekoek”, University of Amsterdam, The Netherlands

X-ray variability studies of the black hole binary Swift J1753.5−012 in soft band: Is there contribution from the disk?

X-ray variability studies of Black hole binaries have been carried out with *RXTE* for over a decade. Due to the limitation of a lower energy bound at 2 keV, the behaviour of variability in the soft band remains mostly unexplored. *Swift*-XRT, having an energy range 0.3–10 keV, provides a rare opportunity to explore the variability in the soft band which is dominated by the disk emission. This could help us directly address the question of the origin of variability. We present, for the first time, very detailed variability studies carried out with the *Swift* XRT in soft band. We study the outburst of the black hole binary Swift J1753.5−012, which has been speculated to have a disk even in the hard state (Miller et al. 2006), making it a very suitable candidate for this study. We observe strong variability in the soft band, which has been suggested to be intrinsic to the disk (Wilkinson et al. 2009). This challenges the truncated disk models. We will discuss the implications of our results on these models and the future scope of our work.

Tuesday – 16:45–17:05

Holger Stiele INAF Osservatorio Astronomico di Brera, Italy

Correlations between timing features and spectral parameters during rise and decay in black hole X-ray binary outbursts

During outburst black hole X-ray binaries evolve through different states, which can be characterized by different timing properties. In addition, changes of spectral parameters between the states can be observed. I studied the correlations between individual spectral parameters and specific timing features for a sample of black hole X-ray binaries. I present the found correlations between the centroid frequency of quasi-periodic oscillations and certain spectral parameters, and discuss their dependencies on the luminosity and other properties of the sources. I find that in the soft intermediate state only certain combinations of spectral and timing parameters are allowed, depending on the direction of the transition.

Tuesday – 17:05–17:25

Alexandra Veledina University of Oulu, Finland

Non-thermal particles in hot accretion flow: unification of spectral and timing properties

The black hole low-mass X-ray binaries have been studied for many decades, however many aspects of their accretion-ejection processes remain uncovered. Among those, the decomposition of total spectrum into separate components (accretion disc, hot inner flow, jet) is one of the most debated. It is generally accepted that the radio emission is produced in the jet far away from the black hole, while the X-rays likely originate from the very vicinity of the compact object. However, the origin of the optical/infrared spectrum is much less certain. The flat power-law continuum frequently found at these wavelengths is inconsistent with being produced by the cool accretion disc or a companion star. In many cases it does not lie on the continuation of the radio power-law either, thus is not dominated by the jet. Further, a complex optical/X-ray correlation rejects the scenario of simple reprocessing. We develop a model, where the optical spectrum consists of two components: synchrotron radiation of the non-thermal particles in the inner flow and reprocessed photons from irradiated accretion disc. We show that the observed spectral and timing properties are naturally explained in this scenario. I will discuss the general concepts of our model and show comparison to the observations.

Black Hole Universe

Tuesday – 17:25–17:45

David Meier Caltech/JPL, USA

Highly Super-Eddington Accreting Black holes: Cygnus X-1s on Steroids

There are some instances in which the accretion rate toward a central black hole may greatly exceed the Eddington limit – by factors of many tens to hundreds. Stellar-mass black hole candidates for such objects include SS433, P098 in M101, N1 in M81, and the object in globular cluster RZ 2109 (NGC 4472). I present a detailed model of P098 at two different times, using the data from Mukai et al. (2003), and I derive mass loss rates and structure parameters of the super-Eddington wind, including size and speed. The model is consistent with a semi-detached binary containing a 25 $M_\odot$ BH and an 8 $M_\odot$ B star filling its Roche lobe – perhaps a future state of sources like Cyg X-1. It would be interesting to investigate the possibility of such objects being progenators of low-mass X-ray binaries. Counterparts in the supermassive BH case would appear as high-covering-factor broad absorption QSOs created in wet mergers, but may be heavily obscured by dust in such situations. Detailed studies of such objects, then, would be possible only with telescopes like *JWST*.

Wednesday

Wednesday – 09:40–10:00

David Cseh CEA Saclay, France

Jet ejection events of the intermediate mass black hole HLX-1

Ultraluminous X-ray sources (ULXs) are variable off-nuclear extragalactic X-ray sources with luminosities greatly exceeding the Eddington luminosity of a 20 $M_{\odot}$ compact object, assuming isotropic emission. ULXs are binary systems containing a compact object that is either a stellar-mass black hole with beamed or super-Eddington emission; or an intermediate-mass black hole (IMBH). I will present the first radio detection of jet ejection events during the transition from hard to soft states of the best IMBH candidate ESO243−49 HLX-1. Despite the very diverse nature of ULXs, some might can bridge the gap between stellar mass and supermassive black holes.

Wednesday – 10:00–10:20

Manfred W. Pakull Observatoire Astronomique de Strasbourg, France

Photon luminosity and mechanical power of accreting black holes

Ten years after the discovery of ionized nebulae around many ultra-luminous X-ray sources we begin to understand the various feedback processes between stellar-mass black holes and the interstellar environment. I will review how the interstellar medium might be used as a colorimeter for the ionising luminosity and for the wind/jet power of these source, and I will report on new studies of X-ray-ionized nebulae. They range from the well-studied nearby eclipsing black hole X-ray binary M33 X-7 to the hyper-luminous NGC 470 X-1 located more than 30 Mpc away. Finally, new VLT/*HST* observations of S26 in the nearby galaxy NGC 7793 are presented, which is an energetic cousin of the Galactic microquasar SS433 and its synchrotron nebula W50. It is argued that both microquasars are probably Compton-thick at X-ray wavelengths and are intrinsically as luminous as their huge jet powers (10^{39} and some 10^{40} erg s^{-1}) suggest.

Black Hole Universe

Wednesday – 10:20–10:40

Fabio Pintore Dipartimento di Astronomia, Universitá di Padova, Italy

X-ray spectral states and temporal properties of Ultraluminous X-ray Sources

We present a systematic analysis of the X-ray spectral variability of a number of Ultraluminous X-ray Sources (ULXs) using *XMM-Newton* observations. It has been suggested that a fraction of ULXs are massive stellar black holes accreting at super-Eddington regimes and their spectral properties can be usually well described by a Comptonization model plus a disc component. We checked the consistency of this spectral model on the basis of the variability patterns of its spectral parameters. Even if the parameters change between observations, the corona usually remains optically thick and cool, possibly showing different spectral states not directly correlated with the luminosity. The sources with high counting statistics exhibit temporal variability that increases with energy, suggesting that strong winds may set in at super-Eddington accretion rates. Under this hypothesis, the variability could be driven by turbulence in the wind as it intersects our line sight. We will present the results of a search for winds in sources with very intriguing temporal properties.

Wednesday – 10:40–11:00

Emanuele Ripamonti Universitá di MIlano-Bicocca, Italy

Investigating the relation between ULXs and metallicity

One of the most promising models for ULXs predicts that they are powered by massive stellar black holes (MSBHs), i.e. stellar black holes with masses above $\sim$25 $M_{\odot}$. Because of the dependence of stellar winds upon metallicity, MSBHs are expected to form only in environments with low-metallicity. I will discuss whether observational evidences actually favour a link between ULXs and low metallicity.

Black Hole Universe

Wednesday – 11:40–12:20

Jason Dexter UC Berkeley, USA

Extremely Faint and Incredibly Close: the Physics of Accretion onto Sagittarius A*

The Galactic center hosts the most intensively studied massive black hole candidate, Sgr A*. Multi-wavelength, time-domain and high spatial resolution observations of Sgr A* offer an unprecedented test of black hole accretion theory. I will review the physics of accretion onto Sgr A* and other low-luminosity ("quiescent") black holes, highlighting important open questions in both the dynamical and radiative properties. I will summarize the results of detailed comparisons of the theory with observations, and discuss the prospects for constraining the parameters of the black hole and its accretion flow. I will argue that we may be on the verge of detecting the shadow of the black hole, which would constitute the first direct evidence for the existence of an event horizon in the Universe.

Wednesday – 12:20–12:40

Alexander Zakharov Institute of Theoretical and Experimental Physics, Russia

Black hole at the Galactic Center

Observations of trajectories of bright stars at the Galactic Center in IR band have been done with an enormous precision. We discuss theoretical studies connected with the observations. A great progress of the Galactic center has been done with VLBI observations in mm band. We review theoretical studies and their links with observations to get constraints on parameters of the Galactic Center potential and as a result to evaluate parameters of the black hole and distributions of stellar cluster and dark matter near the black hole.

References

- A. F. Zakharov, F. de Paolis, G. Ingrosso, A.A. Nucita, Shadows as a tool to evaluate black hole parameters and a dimension of spacetime, New Astronomy Reviews, 56, 64 (2012).
- Zakharov A.F., Nucita A.A., De Paolis F., Ingrosso G., Apoastron shift constraits on dark matter distribution at the Galactic Center, Phys. Rev. D 76, 062001 (2007).

Black Hole Universe

Wednesday – 12:40–13:00

Samia Drappeau Sterrenkundig Instituut “A. Pannekoek”, Amsterdam, The Netherlands

New predictions for X-ray binaries as Galactic gamma-ray and cosmic-ray sources

X-ray binaries (XRBs) are binary systems in which a compact object (neutron star or black hole) accretes matter from a companion star. The accretion processes onto a compact object emit strongly in the X-ray band, making XRBs the brightest sources of X-rays in our galaxy. Also associated with XRBs is radio emission from both discrete ejecta as well as collimated, compact jets. The jets are relativistic outflows launched from the vicinity of the compact object and are believed to be powerful particle accelerators. As a consequence of the intense studies of XRBs from the radio through X-ray bands over the past decades, we can characterize properties such as distinct accretion states, and the disk/jet connection via correlations such as that observed between the radio/IR and X-rays. In the last few years, the rapid development of gamma-ray observations has open a new window on these sources, with at least one solid detection so far. In this talk we present a new lepto-hadronic model that is based on successful work fitting the lower energy, broadband spectra of XRBs in the compact jet-dominated state. Protons (and electrons) are accelerated throughout the jet and cool via radiation and inelastic collisions, and we calculate spectral energy distributions (SEDs) including both hadronic and leptonic induced processes. We present new predictions for the gamma-ray fluxes in the GeV–TeV range, in particular assessing whether these sources will be standardly visible to the planned TeV Cherenkov Telescope Array. Moreover we will discuss neutrino flux predictions from the model, and implications for the Galactic cosmic ray population. This model can also be scaled to describe the SEDs of low-luminosity active galactic nuclei (LLAGN) such as our own Galactic Center black hole Sgr A*.

Wednesday – 13:00–13:20

Farruh Atamurotov National University of Uzbekistan, Uzbekistan

The shadow of black hole in Kerr-Taub-NUT spacetime

The particle motion around Kehagios-Stefsos (KS) black hole immersed in external asymptotically uniform magnetic field has been studied using the Hamilton-Jacobi equation. The Penrose process and particle acceleration mechanisms around rotating black hole have been studied in the framework of new proposed Horava gravity model. The influence of the rotating parameter, magnetic field, and KS parameter on the energetic processes have been described in details. The motion of the massless particles around black hole with nonvanishing gravitomagnetic charge have been studied. We also studied the black hole shadow in the presence of the NUT parameter. The same effect has been considered for the case of KS black hole.

Thursday

Thursday – 09:40–10:20

Ryan Hickox Dartmouth College, USA

AGN evolution and the growth of supermassive black holes

Recent years have seen remarkable advances in our understanding of how supermassive black holes form and grow over cosmic time, and how energy released by active galactic nuclei connects the growth of black holes to their host galaxies and large-scale structures. I will review recent observational and theoretical studies that explore the cosmic evolution of AGN activity over a wide range of scales, from the inner accretion flow to the outer regions of galaxy clusters, with a particular focus on statistical properties of the AGN population from multiwavelength surveys. I will highlight some new results showing strong links between the growth of black holes and star formation in their host galaxies, suggesting that galaxies and black holes grow from a common gas supply. I will also discuss the regimes in which feedback from AGN is especially important in the evolution of host galaxies.

Thursday – 10:20–10:40

Andrea Merloni MPE Garching, Germany

AGN feedback in clusters of galaxies: M87 under the LOFAR microscope

There are multiple lines of evidence, both theoretical and observational, suggesting that radio emitting AGN in the cores of clusters and groups of galaxies may play a fundamental role in determining the physical properties of the most massive galaxies and the thermodynamical state of the intra-cluster gas. After a brief description of such evidence, I will discuss in detail our recent LOFAR observations of the extended low-frequency radio emission from the relativistic jet of M87, the giant elliptical harboring a supermassive black hole at the center of the Virgo cluster. In order to put constraint to the source past activity cycles, images of M87 were produced at frequencies never explored before at our resolutions. We performed a detailed spectral analysis of the extended radio-halo in order to disentangle different synchrotron models and put constraints on source magnetic fields, age and energetics.

Thursday – 10:40–11:20

Tamara Bogdanovic University of Maryland / Georgia Tech, U.S.A.

Gravitational and electromagnetic signatures from merging black holes

In anticipation of the future gravitational wave (GW) detections a lot of effort has been directed towards the study and characterization of the supermassive black hole binaries (SBHBs), which are one of the prime GW targets. However, it may be more than 10 years before a GW interferometer capable of such detections is launched and in the mean time we will continue to rely on the observations of light to study the SBHBs in the universe. In order to make progress in this direction it is essential to gain better understanding of these observationally elusive systems. Ways to achieve this are through improved observational strategies and theoretical modeling of SBHBs. I will describe recent observational and theoretical efforts both of which have complementary aims: to search for and predict the observational signatures associated with the late inspiral and merger of supermassive black holes.

Thursday – 10:40–12:00

Viktoriya Giryanskaya (Morozova) MPI for Gravitational Physics, AEI, Potsdam, Germany

Mass formula for the remnant of black hole binary merger

A formula is derived for the final mass of the remnant black hole after binary black hole merger in terms of spins and masses of the initial black holes. The formula is obtained by fitting the results of many numerical simulations of black hole binary inspiral and merger present in the literature, as well as by exploiting the information about the test particle limit and post-Newtonian description of the system. The formula may be important for calculating gravitational wave background for existing and future gravitational waves detectors, may be applied for improvement of the effective-one-body approach in describing black hole binaries evolution, used to calculate quasi-normal modes of the resulting black hole.

Thursday – 12:00–12:20

Nick Tacik University of Toronto, Canada

Parameter Space Dependence of Junk Radiation in Binary Black Hole Simulations

At the start of numerical simulations of binary black hole inspirals, there is always a brief burst of high amplitude, high frequency radiation, known as “junk radiation”. Here, we investigate how amount of junk radiation depends on the initial separations of the black holes and on their spins. The junk radiation is measured in three ways: The energy it carries away from the system, how it affects the masses of the black holes, and how it changes the spins of the black holes. We also compare the cases of conformally flat initial data and non-conformally flat initial data (Superposed Kerr-Schild initial data).

Thursday – 12:20–13:00

Francesca Panessa IAPS-INAF, Italy

AGN from low to high accretion rates

TBD

Black Hole Universe

Thursday – 14:35–14:55

Richard Plotkin Sterrenkundig Instituut “A. Pannekoek”, Amsterdam, the Netherlands

Weakly Accreting AGN and their Receding Tori: an Infrared View of Unification

In the standard unification paradigm, different classes of Active Galactic Nuclei (AGN) are considered to be the same basic type of object but viewed at different orientation angles. The dusty torus is an essential component in this scheme: from certain lines of sight the torus blocks our view of the innermost regions of the AGN (including the accretion flow onto the central supermassive black hole, and also the AGN's broad emission lines). Here, we examine the mid-infrared properties of a large sample of low-luminosity radio galaxies with a jet beamed toward the Earth (namely BL Lac objects), in order to search for reprocessed dust emission from the torus. We do not see any torus emission. For the first time, we demonstrate that the “missing” emission is not simply outshone by the relativistic jet, implying that the tori of low-luminosity radio galaxies and of luminous quasars are fundamentally different. Turning to the fundamental plane of black hole activity for guidance, I will discuss why the lack of torus emission is best-interpreted as low-luminosity radio galaxies having radiatively inefficient inner accretion flows. I will then place these results into the context of AGN unification, with a focus on comparing how strongly black hole outflows are influenced by intrinsic properties (like the nature of the accretion flow) vs. AGN environment. Our work complements studies at other wavebands, and also at other black hole mass scales, providing further motivation to (continue to) include factors beyond orientation in the next generation of AGN unification models.

Thursday – 14:55–15:15

Sibasish Laha IUCAA, India

The Warm absorbers and the Soft-excess continuum in Seyfert1 galaxies

The warm absorbers (WA) in Seyfert galaxies are a unique probe to the unresolved central active region of an AGN. However the spectral region where they are detected ($\sim$0.2–1 keV) is very complex and in most of the times it shows a presence of Soft-excess (SE) emission. There is no consensus, yet, as to what is the physical origin for such an excess and as such there are several models in use. This leaves an ambiguity in SE modeling and hence estimating the WA parameters. The question is therefore which model to use for SE to estimate the correct values of the warm absorber best fit parameters. In our present work with a case study of a bright Seyfert 1 Galaxy IRAS13349+2438 using the EPIC-pn, RGS, and OM data from *XMM-Newton*, we have shown that the best fit warm absorber parameters obtained are independent of the SE model used, for example blackbody,nthcomp,optxagn. As long as the model describes the SE statistically well. Also we find that the warm absorber parmeters depend significantly on the UV and X-ray continuum we choose while modeling the gas using code CLOUDY. We conclude from our study that we must use a “realistic” continuum corresponding to each source in CLOUDY to estimate correct WA parameters.

Black Hole Universe

Thursday – 15:15–15:35

Jacobo Ebrero SRON Netherlands Institute for Space Research, The Netherlands

The X-ray/UV absorber in NGC 4593

Outflowing gas in active galactic nuclei (AGN), seen as blue-shifted absorption lines in UV and X-ray spectra, is recognized as an important structural feature. The high frequency of occurence of UV and X-ray absorption suggests that the absorbing gas has a high covering fraction, and that is present in all AGN. The AGN wind both heats and removes the interstellar medium (ISM) of the host galaxy, effectively stopping further star formation, and removing the fuel for further black hole growth as well as influencing the surrounding intergalactic medium. If the kinetic luminosity injected in the medium is high enough, then the impact on the host galaxy is sufficient to regulate galaxy growth (cosmic feedback).
We present the results on a recent *Chandra* LETGS observation of the Seyfert galaxy NGC 4593. The source unambiguously reveals the presence of a two-component warm absorber in the X-rays with distinct ionization states. We also present the analysis of an archival *HST*/STIS observation in the UV domain. There is clear evidence of an intrinsic UV absorber with at least 9 kinematic components, characterized by several absorption troughs seen in the CIV, NV, Si IV and Ly α regions. This UV absorbing gas could also be responsible for the lower ionisation WA seen in the X-rays. The lack of variability of the absorbing X-ray components with respect to previous observations points out towards an origin in thermally-diven winds in the putative dusty torus that surround the central supermassive black hole.

Thursday – 15:35–15:55

Minfeng Gu Shanghai Astronomical Observatory, China

The optical variability of radio-loud quasars

The optical variability of a sample of 44 FSRQs and 18 SSRQs in the SDSS stripe 82 region is investigated by using the multi-epoch data covering nine years. The variabilities are clearly detected in each source with the amplitude in the r-band, from $\sim$0.2 mag to $\sim$3.5 mag. Twenty-five of 44 FSRQs show a bluer-when-brighter trend (BWB), while only one FSRQ shows a redder-when-brighter trend, which is in contrast to our previous results. Eight of 18 SSRQs display a BWB. We found an anti-correlation between the Eddington ratio and the variability amplitude in r band for SSRQs, which is similar to that in radio-quiet AGNs. This implies that the thermal emission from the accretion disk may be responsible for the variability in SSRQs. Moreover, we present the optical continuum variability of radio-loud broad absorption-line quasars (BALQs) for the first time for two sources with steep radio spectra.

Black Hole Universe

Thursday – 16:25–16:45

Alex Markowitz University of California, San Diego, U.S.A.

Multi-Time Scale X-ray Spectral Variability in Seyferts

I will review recent insights gained via broadband X-ray spectroscopy on X-ray bright low-redshift Seyfert AGN, concentrating on results from AGN monitoring programs with the recently-ended *RXTE* mission. Time-averaged and time-resolved spectroscopy probe relationships between Seyferts' variable X-ray emission and absorption components, including coronal continua, Fe Kα emission lines, Compton reflection components, and line of sight full- and partial-covering absorbers across Seyferts. The results provide geometrical constraints on circumnuclear accreting and reflecting gas around supermassive black holes, and constraints for a new generation of unification models quantifying molecular torii as inhomogeneous and clumpy.

Thursday – 16:45–17:05

Sunil Chandra Physical Research Laboratory, Ahmedabad, Gujarat, India

Multi-wavelength Variability in Blazars

Blazars are well known to emit copiously over the complete energy spectrum. Their high luminosity, heavenly large distances, high and variable optical polarisation, weak/featureless nature of continuum emission etc confirm these sources to be a part of AGNs family, having a jet of relativistic plasma very close to our line of sight. This is very rare class of AGNs in a sense that the stream of relativistic plasma, generated from very deep and near the central engine is in direct view. So by studying blazars we can study the energetics at very close to the central engine. The spectral energy distributions (SEDs) of blazars are seen to show bi-modality in nature, one part of which peaks at low energies (Sum-mm/IR/Opt/UV) and other at high energies (X-Ray/Gamma-Rays). The low energy generation in blazars is well explained by the Synchrotron emission processes in the jet. The processes behind high energy emission from jet is relatively unclear though several explanations are proposed. The Inverse Compton scattering of low energy seed photons is thought to be the key process for high energy emission in Leptonic approach.
In the present study I have used quasi-simultaneous multi-wavelength variability study as a tool to investigate the possible energy generation processes responsible during several events of flaring. The part of the preliminary work will be presented during the conference.

Black Hole Universe

Thursday – 17:05–17:25

Shuang-Liang Li Shanghai Astronomical Observatory, China

Constraints on jet formation mechanisms with the most energetic giant outbursts in MS 0735+7421

(Abbreviated) Some AGN in central galaxies of clusters lie in giant X-ray cavities which required 10^{55}–10^{62} erg to form. The cavities are thought to be inflated by AGN jets on a timescale of $\sim 10^7$ years. The jets can be either powered by rotating black holes, by the accretion disks surrounding black holes, or both. Observations of these cavities can be used to constrain jet formation mechanisms. We study the most energetic cavity, MS 0735+7421, with a stored energy $\sim 10^{62}$ erg. The luminosity of the AGN in this cavity is $\sim 10^{-5}\, L_{\rm Edd}$, however, the mean jet power required to inflate the cavity is $\sim 0.02\, L_{\rm Edd}$, which implies that the source has experienced strong outbursts previously. During outbursts, the jet power and the mass accretion rate should be significantly higher than their present values. We construct an accretion disk model in which the angular momentum and energy carried away by jets is properly included to calculate the spin and mass evolution of the massive black hole. Different jet formation mechanisms are employed. We find that jets generated with the Blandford-Znajek (BZ) mechanism are unable to produce the cavity. Only jets accelerated with a combination of the Blandford-Payne (BP) and BZ mechanisms can successfully inflate such a giant cavity, if the magnetic pressure is close to equipartition with the total pressure of the accretion disk. For a dynamo generated magnetic field in the disk, such a giant cavity can be inflated by magnetically driven jets only if the initial black hole spin parameter $a_0 > 0.95$. Our calculations show that the final spin parameter a of the black hole is always $\sim$0.9–0.998 for all the computational examples which provide sufficient energy for the cavity of MS 0735+7421.

Thursday – 17:25–17:45

Beatriz Mingo University of Hertfordshire, United Kingdom

An X-ray survey of the 2 Jy sample: implications for identification and accretion in LERGs.

We present new *Chandra* results on a statistically complete subset of objects from the 2 Jy sample of Southern radio galaxies (Wall & Peacock, 1985 MNRAS 216, 173). Our sample consists of 46 steep-spectrum sources with $0.05 < z < 0.7$, and is unique in its homogeneous coverage across several wavelengths (optical, mid-IR and near-IR, radio and X-rays) and the abundance of low luminosity objects. Our results support a scenario in which most Low Excitation galaxies (LERGs) accrete radiatively inefficiently, channelling most of the accretion-derived energy into their jets, which gives these objects a unique position in AGN unification models. We will show that optical line classification alone is not enough to reliably characterise the objects lying in the luminosity break between the Narrow Line (NLRG) and Low Excitation objects, arguing that a multiwavelength approach is needed to determine the accretion mode of these galaxies. We will also discuss the evidence for and against the suggestion that the radiatively inefficient accretion in LERGs is a result of a different fuel source for the black hole.

Black Hole Universe

Friday

Friday – 09:40–10:00

Pieter van Oers University of Southampton, UK

Median stacking of serendipitous radio observations of Sloan Digital Sky Survey active galactic nuclei

One of the major points of interest in the study of galaxies, is why some sources are radio-loud and others are not. To gain insight into this problem we build an un-biased radio sample using serendipitous VLA observations of Active Galactic Nuclei (AGN) selected using Sloan Digital Sky Survey optical spectra, and study the dependence of core radio-loudness on various physical parameters, like black hole mass, ([Oiii]) luminosity and redshift. To avoid "pollution" of our radio data by steep-spectrum radiative processes due to star-formation we constrain ourselves to high frequency 8 GHz X-band. As most of the AGN are distinctly below the normal detection limit we employ a median stacking method as this is shown to be a better indicator of the true average radio flux density than the mean, since the latter is more sensitive to outliers. For non-detections using the stacking method we provide upper limits. We discuss our findings and compare with previous 1.4 GHz VLA FIRST findings.

Friday – 10:00–10:40

Laura Brenneman Harvard-Smithsonian Center for Astrophysics, USA

Probing the Inner Accretion Disk in AGN Using X-ray Spectra

Some of the most extreme physics in the Universe happens in the immediate vicinity of a black hole. In particular, the warping and twisting of spacetime in the strong gravity regime can yield insight into how black holes accrete gas and how relativistic jets are launched. In the case of supermassive black holes that are actively accreting gas from their surrounding host galaxies, we can also learn how the black hole and its host have co-evolved over time. X-ray spectroscopy currently provides the clearest window into the innermost regions of AGN. By examining the effects of Doppler shift and Relativity on the spectral features emitted from the inner disk, we can probe the role that the angular momentum of a black hole plays in shaping the evolution of the AGN and its surrounds. This science is in its infancy, requiring very high signal-to-noise X-ray spectra and computationally intensive, fully relativistic models. I will discuss the methodologies and caveats involved in fitting such models to data from *Chandra*, *XMM-Newton* and Suzaku, and the black hole spin constraints we have currently achieved by modeling relativistically broadened emission signatures from the inner accretion disk. I will also discuss the advancements that future X-ray observatories will make in this field of research.

Friday – 10:40–11:00

Refiz Duro Dr. Karl Remeis-Sternwarte & ECAP, Germany

Broad Iron Kα line in Cygnus X-1 with *XMM-Newton*

We investigate the broad iron Kα line feature in our 4 *XMM-Newton* observations of the black hole Cygnus X-1. The analysis of the feature provides us with the possibility of determining the geometry of the system and its parameters (i.e. the spin, the system inclination, the emissivity profile). In order to constrain the continuum and hence the line parameters better, we use the simultaneous *RXTE* and *INTEGRAL* data (up to $\sim$500 keV). We present the analysis in which we implement geometries where the source of the hard photons is either a corona or a jet. The results show a very high spin, a relativelly low inclination, a standard emissivity line profile, and a low jet height.

Friday – 11:20–11:40

Jiri Svoboda European Space Astronomy Centre of ESA, Spain

Modelling the steep radial emissivity in relativistic iron lines

X-ray spectroscopy of active galaxies and black hole binaries provides an opportunity to explore the innermost regions of black hole accretion discs. Some of the recent measurements have revealed a very steep radial decrease of the disc reflection emissivity, especially in the central region, suggesting the disc-irradiating corona to be compact and very centrally localised. We will discuss whether the special conditions on the corona properties are indeed required, and/or whether the steep radial emissivity could be an artifact of model assumptions. We will present two different effects which might account for the steep radial emissivities, the angular directionality of the reflected radiation properly calculated in the fully relativistic regime and the radial dependence of the accretion disc ionisation. We will show that these effects may also influence the measurements of the black hole angular momentum.

Black Hole Universe

Friday – 11:40–12:00

Alessandra De Rosa INAF/IAPS, Italy

Measuring strong gravity effects in AGN observed with *LOFT*

Thanks to its sensitivity and broad energy range (2–50 keV), *LOFT* will be able to determine with very high signal to noise and accurate continuum subtraction the profile the Fe K-lines in AGN. In this talk we will present detailed simulations showing that observations of 10^4 s exposure will provide a high enough S/N to detect broad Fe lines in 1 mCrab flux AGN, measuring the inner radius of the disk down to the marginally stable orbit and, from this, derive the spin of the BH with a 20% accuracy (10% for fast spin). Moreover the very high throughput of *LOFT* will permit to investigate the Fe line response to flares, and reveal the orbital motion of individual blobs providing BH mass and spin with 25% and 20% accuracy. In addition, thanks to the wide energy band and the large effective area above 10 keV, the variation of the reflection continuum can be measured with a 2% accuracy. We will also present a comparison of the *LOFT* performances with those available in the near future with *XMM-Newton* and *NuSTAR* combined observations.

Friday – 12:00–12:20

Anna Chashkina Sternberg Astronomical Institute, Russia

Black hole spin-up by magnetized disk accretion

In the case of disk accretion, falling matter transfers its angular momentum to a black hole, spinning the black hole up to Kerr parameters $a \sim 1$. Besides, there are electromagnetic processes that can spin the black hole down (Blandford-Znajek process) and exchange angular momentum with the disk (direct magnetic link). For considerably large Kerr parameters, spin-down becomes stronger and a stalls at some equilibrium value depending on the magnetic field strength.

We study black hole spin evolution taking into account these electromagnetic processes. We show that the equilibrium values of Kerr parameter are sensetive to accretion regime. Besides, Blandford-Znajec procceses dominate in standard disk, while direct magnetic link plays primary role in the advection-dominated disks. For advective disks, electromagnetic processes stop the spin-up of the black hole at $a \sim 0.3$. We also show that magnetic field decay near black hole horizon is important for the case of direct magnetic link. We propose that this divergence in spin-up evolution leads to existence of least two populations of the black holes: with large Kerr parameter (quasars and microquasars) and with intermediate values of Kerr parameter (Sgr A*, accretors in X-ray novae).

Friday – 12:20–12:40

Pavel Abolmasov Sternberg Astronomical Institute, Russia

Resolving the Structure of QSO Disks by Microlensing Effects

Gravitational microlensing by the stellar population of lensing galaxies provides an important opportunity to spatially resolve the accretion disk structure in strongly lensed quasars. Some of the objects (like Einstein's cross) are reasonably consistent with the predictions of the standard accretion disk model. In these cases, the structure of high-amplification events may be used to study the inner parts of the accretion disk. Shapes of amplification curves may be used as a probe for the fundamental parameters of supermassive black holes such as mass and spin parameter.
In other cases, the size of the emitting region is larger than predicted by the standard thin disk theory and practically independent on wavelength. This may be interpreted as an optically-thick scattering envelope possibly related to super-Eddington accretion with outflows.

Black Hole Universe

Posters

Poster – P1

Elif Beklen Suleyman Demirel University, Turkey

A View to Black Holes Using the Earth Occultation Data of the *Fermi*-GBM

By using the 12 NaI detectors in the *Fermi*-Gamma Ray Burst Monitor (GBM), we are monitoring the hard X-ray/soft gamma ray sky using the Earth occultation technique. Each time a source in our catalog passes behind the Earth and occultation by the Earth occurs (or exits occultation by Earth). By using the step-like occultation features we can measure the Flux of a source. We are using CTIME data with 8 energy channels spanning 8 keV to 1 MeV for this 12 GBM NaI detectors and spanning 150 keV to 40 MeV for the GBM-BGO detectors. Our GBM Occultation catalog consists of X-ray and gamma ray binaries, active galactic nuclei(AGN), the Crab Nebula, transient sources, globular clusters and many stars, in total 209 sources. Finally we have generated the detected sources list, and we have worked on 12 Black hole candidates (BHC). Regularly updated results are available at the website `http://gammaray.nsstc.nasa.gov/gbm/science/occultation`.

Poster – P2

Yoon Young Chun Sabancı University, Turkey

Jet signature and contribution in XTE J1752−223 via multiwavelength observations

Galactic black hole transients show many interesting phenomena during outburst decays. We present simultaneous *RXTE*, *Swift*, and *INTEGRAL* X-ray observations, and SMARTS optical/near-infrared (O/NIR) observations, of the X-ray transient, XTE J1752−223. ATCA/VLBI radio observations are also shown to confirm the jet appearance. The multiwavelength observations of 120 days in 2010 cover the transition from soft to hard spectral state, and an additional 177.4 ks *INTEGRAL* X-ray observation was obtained 25 days after the transition. The results of this work make this source interesting, showing a few flares in O/NIR, one of those about 20 days after the transition time and another when the X-rays re-brightened. The ATCA observations showed flat radio spectra when all the X-rays, O/NIR, re-brightened after MJD55340. Furthermore, using the simultaneous broad band X-ray spectra, we found that a high energy cut-off is necessary with a folding energy at around 250 keV during the jet is forming. The broad band spectrum is also fit with Comptonization model. These results might be helpful to understand the physical conditions of jet formation and/or its contribution to X-rays in the hard state.

Black Hole Universe

Poster – P3

Salomé Dibi Sterrenkundig Instituut “Anton Pannekoek”, University of Amsterdam, The Netherlands

GRMHD simulations of accretion onto Sgr A*: How important are radiative losses?

We present general relativistic magnetohydrodynamic numerical simulations of the accretion flow around the supermassive black hole in the Galactic centre, Sagittarius A* (Sgr A*). The simulations include for the first time radiative cooling processes (synchrotron, bremsstrahlung, and inverse Compton) self-consistently in the dynamics, allowing us to test the common simplification of ignoring all cooling losses in the modeling of Sgr A*. We confirm that for Sgr A*, neglecting the cooling losses is a reasonable approximation if one believes that the Galactic centre is accreting below $\sim 10^{-8} M_\odot\,\mathrm{yr}^{-1}$, i.e., $\dot{M} < 10^{-7}\dot{M}_{\mathrm{Edd}}$. But above this limit, we show that radiative losses should be taken into account as significant differences appear in the dynamics and the resulting spectra when comparing simulations with and without cooling. This limit implies that most nearby low-luminosity active galactic nuclei are in the regime where cooling should be taken into account if one wants to model them accurately. We further make a parameter study of axisymmetric gas accretion around the supermassive black hole at the Galactic centre. This approach allows us to investigate the physics of gas accretion in general, while confronting our results with the well studied and observed source, Sgr A*, as a test case. We confirm that the nature of the accretion flow and outflow is strongly dependent on the initial geometry of the magnetic field. For example, we find it difficult, even with very high spins, to generate powerful outflows from discs threaded with multiple, separate poloidal field loops.

Poster – P4

Laura Di Gesu SRON Netherlands Institute for Space Research, The Nederlands

X-ray/UV observation of the Seyfert-1 galaxy 1H0419−577

1H0419−577 is a Seyfert 1 galaxy located at redshift $z = 0.104$. It was observed with *XMM-Newton* in the 2010 for 167 ks. To study the ionized gas outflow, a simultaneous UV observation was also performed with *HST*/COS We successfully modeled the broadband spectrum with a disk blackbody model in the optical/UV and a Comptonisation model in the soft X-ray. In the fit the temperature of the seed photons for the Comptonisation model was coupled with the one of the disk blackbody. Variations of the optical thickness of the Comptonising plasma might also explain the spectral variabilty of the soft X-ray spectrum of this source. An outflow was detected in the COS spectrum, with three different kynetic components. We detected a thin, lowly ionized warm absorber in the X-ray spectrum, consistent with the ionization of the UV absorber. Emission lines were detected both in the X-ray and in the UV. The emitting gas is not consistent to be the same as the absorbing gas: the different ionization of the UV lines with respect to the X-ray lines suggests that they arise in different regions of the AGN.

Black Hole Universe

Poster – P5

Abdullo Hakimov Ulugh Beg Astronomical Institute of the Uzbek Academy of Sciences, Uzbekistan

Particle Motion Around Black Hole in Horava-Lifshitz Gravity

Analytical solutions of Maxwell equations around black hole immersed in external uniform magnetic field in the background of the Kehagias-Sfetsos (KS) asymptotically flat black hole solution of Horava-Lifshitz gravity have been found. Influence of magnetic field on effective potential of the radial motion of charged test particle around black hole immersed in external magnetic field in Horava gravity has been investigated by using Hamilton-Jacobi method. Exact analytical solution for dependence of the minimal radius of the circular orbits from KS parameter for motion of test particle around spherical symmetric black hole in Horava gravity has been derived. The critical values of the particle's angular momentum for captured particles by black hole in Horava gravity have been obtained numerically. The comparison of the obtained numerical results with the astrophysical observational data on radii of the innermost stable circular orbits gives us the estimation of the parameter.

Poster – P6

Yi Liu Shanghai Astronomical Observatory, China

Multi-frequency VLBA Polarimetry of GPS Quasar OQ172

We present a study of the multifrequency VLBA polarimetry of GPS quasar OQ172. GPS quasar OQ172 has an extremely high rest-frame rotation measure (RM > 20000 rad m^2) and RM gradient in its inner nucleus. Its VLBI jet is strongly bent around an arc spanning $\gtrsim$100 pc. NIR spectra reveal an unusually large [OIII] line width, which suggests a large mass within the NLR, and/or strong interactions between the emerging jet and dense material therein. We also confirm a new component found in a 6 cm VSOP map of OQ172, and estimate the proper motions curred inner jet. We analyzed 10 hrs of L-, S-, C-, X-, U-band VLBA polarimetry observation, to study: (1) the magnetic field & RM, (2) the GPS absorption mechanism (FFA or SSA?) and associated opacity, and (3) their variations along the jet. We aim to better understand the circumnuclear environment of OQ172, as seen in highly-redshifted ($z = 3.544$) mm-wave emission from 6–70 GHz in the source rest-frame.

Black Hole Universe

Poster – P7

Semyeong Oh Seoul National University, South Korea

Spatially-resolved narrow-line region of two type-I QSOs

The narrow-line region of active galactic nuclei provides a unique opportunity to investigate the interaction between supermassive black holes and their host galaxy. We investigate the properties of NLR of two type-I radio-quiet QSOs, PG1012+008 and PG1307+085, using spatially resolved long-slit spectra obtained at the Very Large Telescope. We detect extended narrow emission lines in both objects out to several kpc from the center, though the central source dominates the luminosity. The broad [OIII] 5007 line with blue wing suggests an outflow of ionized gas. By modelling this line with two Gaussians, i.e., the core and the blue wing, we explore the kinematics of the ionized gas as a function of distance. We compare the results with comparable studies of type-II QSOs.

Poster – P8

Serguei Ossokine University of Toronto, Canada

Rotationally invariant approach to simulation of precessing binary black holes

I will describe a new approach implementing part of the dual-frame coordinate system by Scheel et al that employs quaternions to represnt rotations. This new technique allows one to explore highly precessing binary black hole systems using the Spectral Einstein Code developed by Caltech, Cornell and CITA.

Black Hole Universe

Poster – P9

Montserrat Armas Padilla Astronomical Institute Anton Pannekoek, The Netherlands

The very faint X-ray binary black hole candidate Swift J1357.2−0933: *Swift*/XRT and UVOT analysis of its 2011 outburst.

In the last decade a new population of X-ray transients has been discovered. They show anomalously low peak luminosities (2–10 keV) of 10^{34} to 10^{36} erg s^{-1}. A large fraction of them is expected to harbor accreting neutron stars and black holes in binaries systems. These very faint X-ray binaries provide a new regime to study accretion onto compact objects, and therefore they can improve our understanding of accretion physics and binary evolution models.
We report the study of the 2011 outburst evolution of the newly discovered black hole candidate X-ray binary Swift J1357.2−0933. We analyzed the *Swift* X-ray telescope and Ultraviolet/Optical telescope (UVOT) data taken during the outburst. The low column density towards the source and its proximity ($<$1.5 kpc) provide an exceptional opportunity to study the X-ray spectrum and the optical counterpart in unprecedented detail and search for features such as X-ray bursts, X-ray pulsations and eclipses/dips in the X-ray lightcurve. Its peak luminosity of $\sim 10^{35}$ erg s^{-1} classifies the source as a very faint X-ray transient. If the black hole nature is confirmed, Swift J1357.2−0933 would be the first established black hole very-faint X-ray binary

Poster – P10

Serena Repetto Radboud University Nijmegen, Netherlands

Stellar-mass black hole kicks

It has been known for some time that neutron stars receive kicks (the so-called natal kicks) when they are formed in core-collapse supernovae. Whether black holes receive these kicks is still a matter of debate. We study Galactic stellar black holes in low-mass X-ray binaries and look at their position within the Galaxy: some systems are almost coplanar, while other are found in the halo. Starting from sensible guesses on the initial binary properties and assuming the objects to be originated in the plane of the Galaxy, we integrate their trajectory numerically in the Galactic potential and compare our simulated (R,z) distribution with the observed one.

Black Hole Universe

Poster – P11

Jérôme Rodriguez CEA Saclay, France

IGR J17091−3624: the farthest Galactic black hole binary?

We use the results of four (quasi-)simultaneous radio (ATCA), X-ray (*Swift*, *RXTE*), and Gamma-ray (*INTEGRAL*) observations of the black hole candidate IGR J17091−3624, to try and unveil typical parameters of the systems. The spectral analysis of the X-ray data also favour a distance much greater than that of the Galactic centre. Using the fundamental plane of radio vs. X-ray luminosity we show that the source behaviour is compatible with that of the other black hole sources for distances greater than ∼11 kpc. The quenching luminosities, however, suggest an even higher distance (∼17 kpc and beyond).

Poster – P12

Zhaoyu Zuo Department of Physics, Xi'an Jiaotong University, P. R. China

Simulating the X-ray evolution of late-type galaxies with evolutionary population synthesis

We have modeled the X-ray evolution of late-type galaxies over about 14 Gyr of cosmic history with an evolutionary population synthesis code. We investigate the relations between the X-ray luminosity and other physical properties (i.e., optical luminosity, stellar mass, etc.) of the galaxies, and suggest the decrease in the X-ray luminosity-to-mass ratio (L_X/M) with time is a natural consequence of stellar and binary evolution and the mass accumulating process in galaxies, while the nearly constant value of L_X/L_B, though conflict with the observetions, may be caused by intense obscured star formation activity that leads to a nonlinear relationship between X-ray and B-band emission.

Black Hole Universe