Abstracts for the 6th FERO meeting

30th-31st of August 2012

Astronomical Institute of the Academy of Sciences - Prague
Boční II 1401, 141 00 Praha 4, Czech Republic

The abstracts are in the order of presentations during the meeting.

Thursday 30/8

I. Session: Timing

Fast variability of the iron line red wing in MCG-6-30-15 and NGC 4051

Iossif Papadakis

I will present results on the fast variability of the red wing of the iron line in MCG-6-30-15 and NGC 4051, using archival XMM-Newton and RXTE data, regarding the delays between the line itself and the continuum at high frequencies, as well as the presence of any "peaks" in the power spectrum which may indicate that the line is the result of X-ray reflection on an inhomogeneous disc close to the central black hole.

Measuring strong gravity effects in AGN observed with LOFT

Alessandra De Rosa

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 of the Fe K-lines in AGN. In this talk we will present detailed simulations showing that LOFT-LAD observations will provide a high enough S/N to detect broad Fe lines in up to ~1 mCrab flux, measuring the inner radius of the disc down to the marginally stable orbit and, from this, derive the spin of the BH with high accuracy (10% for the 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 the individual blobs providing BH mass and spin with 25% and 20% accuracy. We will also present a comparison of the LOFT performance with that available in the near future with XMM-Newton and NuStar combined observations.

The relativistic iron line produced by a viscously spreading ring near a massive black hole

Vjačeslav Sochora

We consider a spectral line formed by an X-ray illumination of an accretion ring near a supermassive rotating black hole. The ring is assumed to be gradually dissolved by viscous processes. We consider a simple model spectrum consisting of a power-law primary continuum and K-alpha reflection line of iron, and we show how the observed spectral profile changes in time. Model parameters are view angle of the observer, spin of the black hole, the initial radius of the ring, and its viscosity parameter.

The theory of power spectrum break frequency in multi-flare accretion disc variability models

Tomáš Pecháček

Observed X-ray fluxes from galactic black-hole candidates and active galactic nuclei are remarkably variable. A large class of models in the literature is based on an assumption that this variability is driven by magnetic flares or hot spots residing on the surface of an accretion disc. In my talk I will present a recently developed computationally efficient method for constraining the overall shape of the power-spectrum densities generated by the multi-flare models with exponentially-decaying flare emissivity profiles. I will demonstrate how to use this method to eliminate large subclasses of the model parameter space corresponding to PSDs inconsistent with the observational data.

Time lags in the lamp-post geometry of the compact corona illuminating a black-hole accretion disc

Michal Dovčiak

Recently it was claimed that the time lags among X-ray flux in different energy bands can be used to distinguish between the reflection and absorption scenario for AGNs. We started a new project on study of time lags in the lamp-post geometry of reflection model. In this talk I will show the preliminary results of an accretion disc response to a short flare on the axis above the black hole. The light curves and time dependent spectra for neutral disc will be shown for several heights of the primary source and observer inclinations.

II. Session: Polarization

MoCA: a Monte Carlo code for Accretion

Francesco Tamborra

We developed a Monte Carlo code to study the X-ray polarization in accreting sources. The code, written in IDL, is fully special relativistic and it is modular: by changing the corona and disc parameters it can be applied to several astrophysics situations. On the occasion of the 6th FERO meeting we are going to present the first results applied to AGN. We simulated the overall polarization signal (degree and angle) produced by different corona geometries and we also calculated the expected degree of polarization of the emission Iron line. In the future we are going to include a ray tracing routine to the code in order to offer a fully relativistic and more realistic description of the phenomenon.

Polarization in the lamp-post geometry of the compact corona illuminating a black-hole accretion disc

Michal Dovčiak

The lamp-post geometry was in the past suggested to explain the properties of the relativistic broad iron line. It naturally gives the illumination pattern of the disc and it is claimed that it can explain the timing properties of the observed spectra. The detailed study of the polarization in reflection scenario may be important also for resolving the reflection-absorption dispute as two scenarios explaining the spectral properties of AGN in 2-10keV energy range.

In this talk the main assumptions and results for the neutral disc and unpolarized primary radiation will be summarized. New figures depicting the polarization angle and polarized flux at the detector will be shown to clarify the dependence of the polarization properties on the primary source height and observer inclination.

X-ray polarimetry as a new and independent tool to discriminate reflection from absorption scenarios – Investigating the case of MCG-6-30-15

Frédéric Marin

On the FERO meeting occasion, I will review the latest submitted paper wrote by Marin, Goosmann, Dovciak, Muleri, Porquet, Grosso, Karas and Matt concerning the modelling of X-ray polarization spectra emerging from the two competitive scenarios that are proposed to explain the broad Fe Kα line in MCG-6-30-15. In the submitted letter, the polarization signature of complex absorption was studied for a partial covering scenario using a clumpy wind and compared to a reflection model based on the lamp-post geometry. The shape of the polarization percentage and angle as a function of photon energy were found to be distinctly different between the reflection and the absorption case. Indeed, the relativistic reflection produces significantly stronger polarization in the 1–10 keV energy band than absorption. The spectrum of the polarization angle adds additional constraints: in the absorption case it shows a constant shape, whereas the relativistic reflection scenario typically leads to a smooth rotation of the polarization angle with photon energy. Based on this work, we concluded that a soft X-ray polarimeter on-board a small X-ray satellite may already discriminate between the absorption and the reflection scenario. The small X-ray polarimetry mission XIPE, which has recently been proposed to the European Space Agency for a launch in 2017 and currently reviewed for a final decision in next September would be suitable in this respect.

III. Session: Galactic black holes

Spectral fitting of absorption iron lines in 4U1630-472

Agata Różańska

We fit Suzaku observations of black hole transient 4U1630-472 with models of emission from an accretion disc atmosphere. All models are computed using radiative transfer calculations with Compton scattering and photoionization on heavy elements. I will present first results of such fitting and show, that iron lines in absorption can be created due to high temperature of an accretion disc around black hole.

Ubiquitous equatorial accretion disc winds in black hole soft states

Gabriele Ponti

The advent of high resolution X-ray spectroscopy has allowed to probe the presence and physical conditions of highly ionised winds in Black Hole Binaries (BHB). In particular, FeK winds are generally associated with large outflow velocities (10^3 km/s) and large mass loads, indicating mass outflow rates of the order or higher than the mass inflow rate. These winds are, thus, key components in our understanding of the accretion onto BH mechanism. We analysed all the HETG Chandra, XMM-Newton and Suzaku observations of every Low Mass X-ray Binary (LMXB) to investigate these winds. In GRS1915+105 we observe both a strong correlation between the presence of the wind and the source state and an anti-correlation with the jet (the FeK wind being detected in 12 out of 12 observations in the soft state and absent in 12 out of 13 observations in the hard state). We show that all the dipping LMXB share this same behaviour, while the non-dipping LMXB never show any sign of FeK winds, regardless of the state. We interpret this as a strong evidence for flattened disc winds as a ubiquitous component of the jet-free soft states.

Friday 31/8

IV. Session: Other ways to FERO

X-ray continuum fitting of accretion disc spectra

Michal Bursa

Fitting of X-ray continuum has become a powerful way of measuring black hole spins in stellar mass X-ray binaries. Still, a good caution needs to be taken when analyzing observation data. In case of almost every black-hole X-ray binary where BH spin has been estimated using this method, the result shows a drop of the estimated spin with increasing luminosity after luminosity exceeds a treshold value of ~0.3 Eddington. This tells us that the accretion disc model that has been used (Novikov-Thorne thin disc) starts to have difficulties to accurately describe the real disc spectra, which are significantly softer than the one predicted by the model. However, it is not only the disc model which shapes the final spectrum. Equally important is the spectral hardening predicted by disc atmosphere models (e.g. BHSPEC). The talk will summarize the basics of the fittig method, processes that modify emergent spectrum of thermal discs and depart it from being blackbody. It will show the effects of spectral hardening factor, its dependence on luminosity and alpha-viscosity and implications for spectral fittings.

Testing the Kerr-nature of black hole candidates

Cosimo Bambi

The final product of the gravitational collapse is thought to be a Kerr black hole and astronomers have discovered many good astrophysical candidates. In order to confirm the Kerr-nature of these objects, we need to probe the geometry of the space-time around them and check if it is consistent with the predictions of the Kerr metric. In this talk, I will discuss how the study of the properties of the radiation emitted by the gas in the accretion disc can test the Kerr black hole hypothesis with present and near future data.

Resolving quasar accretion discs by gravitational microlensing

David Heyrovský, Lukáš Ledvina

Gravitational lens systems, in which the light of a background quasar passes directly through the stellar population of the lensing galaxy, can give rise to the additional microlensing effect. As the quasar moves relative to the stars, the caustic network formed by the local gravitational field provides a time-varying amplification of the flux from the quasar. The high angular resolution provided by the caustics permits an observer to resolve the structure of the emitting region of the quasar accretion disc. We present an overview of the theory and observations of quasar microlensing and demonstrate the sensitivity of simulated X-ray microlensing light curves to parameters of the quasar accretion disc models.

Massive magnetic dipole in relativity

Vladimír Karas

Massive magnetic dipole solutions are an example of non-Kerr solutions for compact objects that can be relevant for the discussion at this workshop. These spacetimes often suffer from the presence of singularities that are not hidden by an event horizon, however, Occam's razor may not be the best argument to ignore them a priori.

Catch me if you can: is there a 'runaway-mass' black hole in the Orion Nebula Cluster?

Ladislav Šubr

We investigate the dynamical evolution of the Orion Nebula Cluster (ONC) by means of direct N-body integrations. A large fraction of residual gas was probably expelled when the ONC formed, so we assume that the ONC was much more compact when it formed compared to its current size. Hence, we assume that few-body relaxation played an important role during the initial phase of evolution of the ONC. In particular, three body interactions among OB stars likely led to their ejection from the cluster and, at the same time, to the formation of a massive object via 'runaway' physical stellar collisions. The resulting depletion of the high mass end of the stellar mass function in the cluster is one of the important points where our models fit the observational data. We speculate that the runaway-mass star may have collapsed directly into a massive black hole (more than 100 solar masses). Such a dark object could explain the large velocity dispersion of the four Trapezium stars observed in the ONC core. We further show that the putative massive black hole is likely to be a member of a binary system with ~70% probability. In such a case, it could be detected either due to short periods of enhanced accretion of stellar winds from the secondary star during pericentre passages, or through a measurement of the motion of the secondary whose velocity would exceed 10km/s along the whole orbit.

V. Session: Observations of AGN

Active galaxy 4U 1344-60: did the relativistic line disappear?

Jiří Svoboda

X-ray bright active galactic nuclei represent a unique astrophysical laboratory for studying accretion physics around super-massive black holes. 4U 1344-60 is a bright Seyfert galaxy which revealed relativistic reflection features in the archival XMM-Newton observation. I will present the spectroscopic results of new data obtained with the Suzaku satellite and compare them with the previous observation. The X-ray continuum of 4U 1344-60 can be well described by a power-law component with the photon index 1.7 modified by a fully and a partially covering local absorbers. We measured a substantial decrease of the fraction of the partially absorbed radiation from around 45% in the XMM-Newton observation to less than 10% in the Suzaku observation while the power-law slope remains constant within uncertainties. The iron line in the Suzaku spectrum is relatively narrow without any suggestion for relativistic broadening. Regarding this we interpret the iron line complex in the archival XMM-Newton spectrum as a narrow line plus an enhanced emission from the innermost accretion flow. The detected red-shifted iron line emission was probably a temporarily enhanced emission from the innermost accretion flow during the XMM-Newton observation.

Multiwavelength campaign on Mrk 509: testing realistic comptonization models

Pierre-Olivier Petrucci

The origin of the different spectral components present in the high energy (UV to X-rays/gamma-rays) spectra of Seyfert galaxies is still highly debated. One of the major limitations, in this respect, is the lack of really simultaneous broad-band observations that allow us to disentangle the behavior of each component and to better constrain their inter-connections. The 1-month monitoring (10 observations, 1 every 4 days, in October/November 2009) of the Seyfert 1 galaxy Mkn 509 simultaneously with XMM and INTEGRAL provide a unique opportunity to test simultaneous UV to X-rays/gamma rays data against physically motivated broad -band models. Each observation has been fitted with a realistic thermal comptonisation model for the primary continuum. In agreement with the observed correlation between the UV and soft X-ray flux, we use a thermal comptonisation component for the soft X-ray excess. We also include a warm absorber and a reflection component, as required by the precise studies previously done by our consortium. The UV to X-rays/gamma-rays emission of Mkn 509 can be well fitted by these components. We are able to constrain the presence of two different coronae: a very hot (kT ~ 100 keV), optically-thin (tau ~ 0.5) plasma producing the primary continuum and a warm (kT ~ 1 keV), optically-thick (tau ~ 10-20) corona (the warm upper layer of the accretion disc?) as the origin of the soft X-rays. We will present our results in this talk and discuss the direct constraints (size, location, variability origin) we obtained on these different emitting regions.

A Chandra HETG View of MCG+8-11-11

Kendrah Murphy

We present preliminary results of an analysis of a 118 ks HETG observation of the X-ray bright, Seyfert 1 galaxy MCG +8-11-11, in conjunction with 100 ks of archival Suzaku data. We applied self-consistent, broadband spectral fitting models MYTorus and PEXMON to the HETG, XIS and HXD-PIN data to investigate the signatures of distant absorption and reflection. Both the Chandra and Suzaku data are necessary to determine robust constraints on the physical parameters of the system: while Chandra is better suited for investigating narrow absorption and emission line features, Suzaku aids in investigating the continuum and relativistic line emission. We find evidence of Fe Kα, Fe Kβ, Ni Kα and Fe XXVI line emission and, using the MYTorus model, we find that both sets of data are consistent with a Compton-thick reprocessor (NH~10^24 cm^-2) that is out of the line-of- sight.

Measuring black hole spins in AGN: where do we stand?

Matteo Guainazzi

Measuring the spin in a sizeable sample of local AGN has been one of the big hopes of modern X-ray astrophysics. I will try and review where we stand on this issue, highlighting the significance of the existing measurements, the main issues affecting them, and the perspectives of overcoming them through future observations with new facilities like NuSTAR and ASTRO-H. I will also sketch possible multi-wavelength approaches, which may help us validating/falsifying the conclusions drawn so far, in order to stimulate discussions and opinions during the meeting.