Book of Abstract

Spanish X-Ray Astronomy 2017
The path towards Athena

Instituto de Astrofísica de Andalucía

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Athena: ESA's X-ray observatory to study the Hot and Energetic Universe

Francisco J. Carrera (IFCA, CSIC-UC)

A.1 – *Abstract:*
Athena is a mission proposed to address the science theme "The Hot and Energetic Universe" which has been selected by ESA in its Cosmic Vision 2015-2025 programme. It has three key scientific objectives: 1) Determine how and when large scale hot gas structures formed in the Universe and track their evolution from the formation epoch to the present day 2) Perform a complete census of black hole growth in the Universe, determine the physical processes responsible for that growth and its influence on larger scales, and trace these and other energetic and transient phenomena to the earliest cosmic epochs 3) Provide a unique contribution to astrophysics in the 2030s by exploring high energy phenomena in all astrophysical contexts, including those yet to be discovered.This will be achieved by a large X-ray observatory offering spatially-resolved X-ray spectroscopy and deep wide-field X-ray spectral imaging with performance greatly exceeding that offered by current X-ray observatories.

The Wield Field Imager (WFI) for Athena

Arne Rau (MPE-Garching, Germany)
On behalf of the Athena/WFI Proto-Consortium

A.2 – *Abstract:*
The Wide Field Imager (WFI) is the one of the two scientific instruments of Athena ESA's next large X-ray Observatory with launch in 2028. Theinstrument will provide two defining capabilities to the mission sensitive wide-field imaging spectroscopy and excellent high-count rate performance. It will do so with the use of two separate detectors systems, the Large Detector Array (LDA) optimized for its field of view ($40' \times 40'$) with a 100 fold survey speed increase compared to existing X-ray missions, and the Fast Detector (FD) tweaked for high throughput and low pile-up for point sources as bright as the Crab. In my talk I will present the key performance parameters of the instrument and their links to the scientific goals of Athena and summarize the status of the ongoing development activities.

The Athena X-ray Integral Field Unit (X-IFU)

Didier Barret (IRAP/CNRS, France)
On behalf of the X-IFU Consortium

A.3 – *Abstract:*
The Athena X-ray Integral Field Unit (X-IFU) is a high-resolution X-ray spectrometer, providing 2.5 eV spectral resolution, over a $5'$ (equivalent diameter) field of view, and count rate capabilities up to 1 Crab in the 0.2-12 keV range. Approaching the end of its feasibility study, I will briefly recall the scientific objectives of Athena driving the XIFU specifications and will describe its current baseline configuration and the expected performances. I will outline the on-going technology developments that will enable the X-IFU.

The Spanish scientific contribution to Athena

Giovanni Miniutti (CAB, INTA-CSIC)

S.1 – *Abstract:*
Many of the scientific topics that will be addressed and studied with unprecedented detail with Athena are currently the focus of the activities of Spanish-based research groups. This expertise is crucial to provide scientific advise and support to the mission. It is helping to shape and refine the mission parameters with the goal of maximizing the mission scientific return. I will review the Spanish scientific contribution to the Athena mission, as well as the relevant research topics associated with the main Athena scientific theme: The Hot and Energetic Universe.

Synergies between CTA, SKA and Athena

Iván Agudo (IAA-CSIC)

S.2 – *Abstract:*
During the coming decade, we foresee an exciting opportunity when a number of last generation astronomical facilities will come online together. CTA, SKA, and Athena, covering the very-high-energy gamma-ray domain, the radio spectrum, and the X-ray range, respectively, are among these facilities. To boost the maximization of their science output, scientific and operational synergies need to be explored. In this talk, I will introduce the planned state-of-the-art performance of these facilities, as well as their key science projects, with emphasis on the potential synergies between the three observatories. The latter lie mainly (but not only) on the study of non-thermal astrophysical processes emitting along the entire electromagnetic spectrum.

The Spanish contribution to Athena

Javier Gómez Elvira (CAB, INTA-CSIC)

S.3 – *Abstract:*
The Spanish technical contribution to the ATHENA payload is focused in X-IFU. That is a very complex instrument for many reasons; one of them is the requirement of its focal plane assembly (FPA) to operate at milikelvin temperature in a very stable way and with high level of electrical and mechanical isolation from the external environment. Spain has two main contributions: at the Dewar design to guarantee the FPA requirements and in the read out electronics. INTA is in charge of the former and IFCA in the latter. In the talk we will give a broad view of the X-IFU instrument with special emphasis in the contribution of the Spanish institutions.

Synergies between GTC and Athena

Romano L.M. Corradi (GTC)

S.4– *Abstract:*
I will present the status of the 10.4m Gran Telescopio Canarias (GTC). I will describe how the GTC will look like at the beginning of next decade according to the current instrumentation plan that is funded and under execution. We also plan to open soon a formal process involving the GTC community to define the role and instrumentation plan of the telescope beyond 2020. This is an opportunity to strengthen the potential synergy of this major Spanish optical facility in the Northern hemisphere with the Athena mission.

Synergies between OCTOCAM and Athena

Antonio de Ugarte (IAA-CSIC)

S.5 –

Athena Community Office

Silvia Martínez-Núñez (IFCA, CSIC-UC)
On behalf of the ACO team

S.6 – *Abstract:*
The Athena Community Office (ACO) was established by ESA's Athena Science Study Team (ASST) in order to obtain support in performing its tasks assigned by ESA, and most especially in the ASST role as "focal point for the interests of the broad scientific community". The ACO is led by the Instituto de Física de Cantabria (CSIC-UC). Further ACO contributors are the University of Geneva, MPE and IRAP. In this talk, we present ACO to the Spanish X-ray Astronomy Community, reporting its main responsibilities, which are: assist the ASST in organising and collecting support from the Athena Working Groups and Topical Panels; organise and maintain the documentation generated by the Athena Working Groups and Topical Panels; manage the Working Group and Topical Panel membership lists; assist the ASST in promoting Athena science capabilities in the research world, through conferences and workshops; keep a record of all papers and presentations related to Athena; support the production of ASST documents; produce and distribute regularly an Athena Newsletter, informing the community about all missions and science developments; maintain the Athena Community web portal; maintain an active communication activity; promote, organise and support Athena science related public outreach, in coordination with ESA and other agencies involved when appropriate; and, design, produce materials and provide pointers to available materials produced by other parties. In summary, ACO is meant to become a focal point to facilitate the scientific exchange between the Athena activities and the scientific community at large, and to disseminate the Athena science objectives to the general public.

Athena prospects on diffuse X-ray emission from hot bubbles

Martín A. Guerrero (IAA-CSIC)

X1.1 – *Abstract:*
The unprecedented sensitivity and spectral resolution of Athena will made a unique contribution to the study of the diffuse X-ray emission from hot bubbles associated with planetary nebulae and Wolf-Rayet bubbles. Here we describe the before and after Athena for the study of the hot gas in Galactic hot bubbles.

Unveiling the progenitor scenario of thermonuclear runaway SNe with Athena

Miguel A. Pérez Torres (IAA-CSIC)

X1.2 – *Abstract:*
We will discuss the prospects for probing Type Ia SNe progenitor scenarios with Athena X-ray satellite. In particular, Athena can be used at a low time-cost for searching the putative prompt X-ray emission arising, in the single-degenerate scenario, from the circumstellar interaction of the exploding star with its surroundings. The huge improvement in sensitivity of Athena with respect to their predecessors will allow us to unambiguously discern which progenitor scenario (single-degenerate vs. double-degenerate) applies to SNe Ia, thus solving this long-standing issue, which has implications not only for stellar evolution theory but also for cosmology.

Nova explosions in X-rays

Gloria Sala (Universitat Politècnica de Catalunya)

X1.3 – *Abstract:*
Novae are explosive events on accreting white dwarfs. The outbursts causes the ejection of a fraction of the accreted material, enriched with freshly nucleosynthesis products. The atmosphere expands powered by H-burning on the white dwarf surface, shining as a bright supersoft source. In addition, the expansion of the ejecta at high velocities and its interaction with the circumstellar material causes hard X-ray emission. X-ray spectroscopy is key to understand the accretion and ejection processes in this objects. Observed X-ray spectra are rich in emission and absorption lines, show more than one velocity components and time variability. In this talk we will see what can be learn with past and recent X-ray observations with novae and what will we learn with Athena

Accretion and outflows in accreting black holes: the extreme case of V404 Cygni

Teo Muñoz-Darias (IAC)

X2.1 – *Abstract:*
X-ray observations performed during the last few decades have provided a rich data base on accreting black holes and neutron stars in X-ray binaries. A strong coupling between the properties of the accretion flow and the presence of outflows, such as radio-jets and X-ray winds, has been found to be a fundamental characteristic of black hole systems; a feature which might be shared by super-massive black holes in active galactic nuclei. I will present some novel results corresponding to the 2015 outburst of the prototypical black hole transient V404 Cyg (Muñoz-Darias et al. 2016, Nature / 2017 MNRAS). During this event, arguably the most interesting of its kind in decades, we have observed, using the GTC-10.4 m optical telescope, a sustained outer accretion disc wind, which is simultaneous to the radio jet. We find that this low temperature outflowing wind has a large covering factor, expands at 1 % of the speed of light and triggers a nebular phase once accretion sharply drops and the ejecta become optically thin. I will discuss the implications of these results in the context of black hole accretion.

Evidence of Compton cooling during an X-ray flare supports a neutron star nature of the compact object in 4U1700–37

María Martínez-Chicharro (Universidad de Alicante)

X2.2 – *Abstract:*
Based on new Chandra X-ray telescope data, we present empirical evidence of plasma Compton cooling during a flare in the non pulsating massive X-ray binary 4U1700–37. This behavior might be explained by quasi-spherical accretion onto a slowly rotating magnetised neutron star. In quiescence, the neutron star in 4U1700–37 is surrounded by a hot radiatively cooling shell. Its presence is supported by the detection of mHz quasi periodic oscillations likely produced by its convection cells. The high plasma temperature and the relatively low X-ray luminosity observed during the quiescence, point to a small emitting area $\sim 1\,\mathrm{km}$, compatible with a hot spot on a NS surface. The sudden transition from a radiative to a significantly more efficient Compton cooling regime triggers an episode of enhanced accretion resulting in a flare. During the flare, the plasma temperature drops quickly. The predicted luminosity for such transitions, $\sim 3 \times 10^{35}\,\mathrm{erg\,s^{-1}}$, is very close to the luminosity of 4U1700–37 during quiescence. The transition may be caused by the accretion of a clump in the stellar wind of the donor star. Thus, a magnetised NS nature of the compact object is strongly favoured.

Understanding the environment in HMXBs with RGS

José Joaquín Rodes (Universidad de Alicante/SRON)

X2.3 – *Abstract:*
We present the spectral analysis of two XMM-Newton observations of the supergiant X-ray binary system Cen X-3. In particular, we focus on the eclipse and out-of-eclipse spectra in order to compare the properties of the environment around the compact object. We analysed the high-resolution spectra collected by the reflection grating spectrometer on board XMM-Newton. We studied eclipse and out-of-eclipse spectra separately. We explored several continuum models in SPEX for which we studied the properties of the emitting and absorbing matter depending on the emission and absorption lines we identified in our spectra. We found that the X-ray continuum is absorbed by a neutral gas and photoionised matter. Emission lines from Si V, Mg XII, Mg XI and Ne X were detected in the eclipse spectrum but seemed to be absent in the out-of-eclipse spectrum. However, we detected an absorption line from Mg IX in the out-of-eclipse spectrum which were not detected in the eclipse spectrum. On the other hand, the level of counts above 20 Å, is compatible with the X-ray background.

Vertical structure of a LMXB accretion disc

Felipe Jiménez-Ibarra (IAC)

X2.4 – *Abstract:*
Low-mass X-ray binaries are binary systems harboring an accreting compact object, either a neutron star or a black hole, and a companion star less massive than the Sun. These objects are among the brightest X-ray sources in the sky, allowing us to study in great detail both the accretion process and geometry, and the fundamental properties of the compact objects. We obtained GTC-10.4m phase-resolved spectroscopy of the optical counterpart of the neutron star transient system Aquila X-1 during three consecutive accretion episodes in 2011, 2013 and, recently, in 2016. Some of these spectra show high excitation emission lines (e.g. Bowen blend at $\sim$4640 Å) arising from reprocessing on the donor star, and therefore trace its movement. We carried out Doppler mapping in order to determine the radial velocity of these features (Kem). Since Kem traces the motion of the irradiated, inner side of the donor star, its velocity is smaller than the radial velocity of the centre of mass of the companion (K2), which we have recently determined through infrared spectroscopy. By combining Kem with K2 we are able to determine the so-called K-correction. The latter is closely related with fundamental parameters of the system and can be expressed as function of the mass ratio of components and the accretion disc opening angle. In this work we present strong constraints to the accretion disc opening angle obtained, first time, from direct measurements and detailed modelling (Jiménez-Ibarra et al 2017, in prep.).

Broad-band X-ray analysis of neutron star LMXBs: the case of 4U 1608–52

Montserrat Armas Padilla (IAC)

X2.5 – *Abstract:*
Since the dawn of X-ray astronomy many efforts have been made to model the X-ray spectra of neutron star LMXBs. Which is the neutron star surface contribution to both the soft energy range and the hard component has been a topic of debate for decades. However, model degeneracy stands in the way of elucidate its specific role. I will review the state-of-the-art of this problem and present a detailed study of the spectral evolution of the classical neutron star X-ray transient 4U 1608–52 using Suzaku broad-band X-ray data during its 2010 outburst decay. Here, we test the proposed, "universal" 3-component model for neutron star low-mass X-ray binaries, which aims to solve the degeneracy problem and naturally explains the properties of the fast variability. I will report on a comprehensive spectral study covering all the classical spectral states. Our results support the idea that black hole and neutron star low-mass X-ray binaries undergo a very similar state evolution during their accretion episodes.

A propelling neutron star in the enigmatic Be star γCas

José Miguel Torrejón Vázquez (Universidad de Alicante)

X2.6 – *Abstract:*
γ Cassiopeia (γ Cas), is known to be a binary system consisting of a Be-type star and a low-mass ($M \sim 1\,M_{\odot}$) companion of unknown nature orbiting in the Be-disc plane. We apply the quasi-spherical accretion theory on to a compact magnetized star and show that if the low-mass companion is a fast spinning neutron star, the key observational signatures of γ Cas are remarkably well reproduced. Direct accretion on to this fast rotating neutron star is impeded by the propeller mechanism. In this case, around the neutron star magnetosphere a hot shell is formed which emits thermal X-rays in qualitative and quantitative agreement with observed properties of the X-ray emission from γ Cas. We suggest that γ Cas and its analogues constitute a new subclass of Be-type X-ray binaries hosting rapidly rotating neutron stars formed in supernova explosions with small kicks.

XMM-Newton spectroscopy of the accreting magnetar candidate 4U0114+65

Graciela Sanjurjo (Universidad de Alicante)

X2.7 – *Abstract:*
Aims. 4U0114+65 is one of the slowest known X-ray pulsars. We present an analysis of a pointed observation by the XMM-Newton X-ray telescope in order to study the nature of the X-ray pulsations and the accretion process, and to diagnose the physical properties of the donors stellar wind.
Methods. We analysed the energy-resolved light curve and the time-resolved X-ray spectra provided by the EPIC cameras on board XMM-Newton. We also analysed the first high-resolution spectrum of this source provided by the Reflection Grating Spectrometer.
Results. An X-ray pulse of 9350 ± 160 s was measured. Comparison with previous measurements confirms the secular spin up of this source. We successfully fit the pulse-phase-resolved spectra with Comptonisation models. These models imply a very small ($r \sim 3$ km) and hot ($kT \sim 2$-3 keV) emitting region and therefore point to a hot spot over the neutron star (NS) surface as the most reliable explanation for the X-ray pulse. The long NS spin period, the spin-up rate, and persistent X-ray emission can be explained within the theory of quasi-spherical settling accretion, which may indicate that the magnetic field is in the magnetar range. Thus, 4U 0114+65 could be a wind-accreting magnetar. We also observed two episodes of low luminosity. The first was only observed in the low-energy light curve and can be explained as an absorption by a large over-dense structure in the wind of the B1 supergiant donor. The second episode, which was deeper and affected all energies, may be due to temporal cessation of accretion onto one magnetic pole caused by non-spherical matter capture from the structured stellar wind. The light curve displays two types of dips that are clearly seen during the high-flux intervals. The short dips, with durations of tens of seconds, are produced through absorption by wind clumps. The long dips, in turn, seem to be associated with the rarefied interclump medium. From the analysis of the X-ray spectra, we found evidence of emission lines in the X-ray photoionised wind of the B1Ia donor. The Fe Kα line was found to be highly variable and much weaker than in other X-ray binaries with supergiant donors. The degree of wind clumping, measured through the covering fraction, was found to be much lower than in supergiant donor stars with earlier spectral types.
Conclusions. The XMM-Newton spectroscopy provided further support for the magnetar nature of the neutron star in 4U0114+65. The light curve presents dips that can be associated with clumps and the interclump medium in the stellar wind of the mass donor.

Order parameters for the high-energy spectra of pulsars

Diego F. Torres (ICREA & Institute of Space Sciences)

X2.8 – *Abstract:*
From the hundreds of gamma-ray pulsars known, only a handful show non-thermal X-ray pulsations. Instead, nine objects pulse in non-thermal X-rays but lack a counterpart at higher energies. What order parameters describe the spectral variety, making the pulsars GeV and/or X-ray bright? Can observations in only one portion of the spectra predict detectability in the other? Can we expect a population of MeV-peaking pulsars? We normally fit observational spectra just with phenomenological functions (a power law with a cutoff in gamma-rays, or a log parabola from X-rays up). Here we shall present the results of a relatively simple physical model for the magnetospheric emission of pulsars above 1 keV, with which we start tackling these questions. It is based on synchro-curvature emission, and includes 1D time-dependent particle propagation. The model seems to contain the basic ingredients needed to describe all observed spectra well: With just four physical parameters, we can git gamma/X-ray pulsar spectra along seven orders of magnitude, providing an interpretation for the appearance of sub-exponential cutoffs at high energies, or the flattening of the X-ray spectra at soft energies. We revise prospects for future observations with existing and forthcoming satellites, and focus on the precious information they will bring for the physics of pulsar magnetospheres.

e-XTP: a near-future China-EU mission for X-ray timing and polarization

Margarita Hernanz (ICE, CSIC-IEEC)

X3.1 – *Abstract:*
The enhanced X-ray Timing and Polarimetry mission (e-XTP) is a science mission designed to study the state of matter under extreme conditions of density, gravity and magnetism. In addition to science contributions from all around Spain (previous LOFT and current XIPE teams), at ICE (CSIC) we are leading the Wide Field Monitor instrument design.

THESEUS: The Spanish Contribution

Alberto J. Castro-Tirado (IAA-CSIC)

X3.2 – *Abstract:*
We will describe the THESEUS Mission and detail the Spanish participation.

SIXTE: physically based simulations for the X-IFU calorimeter

Pablo Eleazar Merino Alonso (XRAGUA - Universidad Alicante)

X3.3 – *Abstract:*
SIXTE is the most detailed simulator of the future Athena telescope, allowing very realistic simulations for both instruments: the X-IFU calorimeter and the WFI spectrometer. SIXTE serves as an assessment tool in both scientifc and technological development of Athena. It implies a qualitative difference from any currently available simulator, due to the grade of detail achieved in the physical description of the instrument. Simulating the impact of the new technology with respect to existent telescopes is not possible without this difference that SIXTE makes over the existent tools. From the UA we contribute to the development of SIXTE, by improving light curve information treatment and by integrating the tool "tessim", for detailed single pixel temperature evolution description, in a more user-friendly format. Using SIXTE-generated simulations, we have developed several exercises on the scientific capacities of the calorimeter X-IFU. First, close source discrimination capacity has been explored in relation with sources bright ratio, spectral model and separation. The impact on low energy science (mainly He like triplet) of Beryllium filters has been studied.

X-ray variability of Seyfert 1.8/1.9 galaxies

Lorena Hernández García (Universidad de Valparaíso, Chile)

X4.1 – *Abstract:*
Seyfert 1.8/1.9 are sources showing weak broad Hα components in their optical spectra. According to unification schemes, they are seen with an edge-on inclination, similar to type 2 Seyfert galaxies, but with slightly lower inclination angles. We used the 15 Seyfert 1.8/1.9 in the Véron Cetty and Véron catalog with public data available from the Chandra and/or XMM-Newton archives at different dates, with timescales between observations ranging from days to years, to study their X-ray variability properties. X-ray variability is found to be common in these nuclei. A comparison between the samples of Seyfert 1.8/1.9 and 2 shows that, even if the main variability pattern is due to intrinsic changes of the sources in the two families, these nuclei exhibit different variability properties in the UV and X-ray domains. In particular, variations in the broad X-ray band on short timescales (days to weeks), and variations in the soft X-rays and UV on long timescales (months to years) are detected in Seyfert 1.8/1.9 but not in Seyfert 2. Overall, we suggest that optically classified Seyfert 1.8/1.9 should be kept separated from Seyfert 2 galaxies in UV/X- ray studies of the obscured AGN population because their intrinsic properties might be different.

Intermediate-mass black holes in dwarf galaxies out to redshift ~ 2.4

Mar Mezcua (Institut of Space Sciences)

X4.2 – *Abstract:*
How supermassive black holes form is still one of the long-standing questions in astronomy. In order to reach 10^9 $M_\odot$ when the Universe was less than ~ 1 Gyr old, they should have started as seed intermediate-mass black holes (IMBHs) of 10^2-10^6 $M_\odot$. The presence of IMBHs at $z > 7$ is difficult to prove; however, those seed IMBHs that did not grow into supermassive black holes should be found in local dwarf galaxies resembling the first galaxies formed at early epochs. I will present observational evidence that a population of IMBHs exists in dwarf galaxies based on the X-ray stacking analysis of low-mass galaxies in the Chandra COSMOS-Legacy survey and on the finding of AGN X-ray emission in 40 dwarf galaxies at redshifts ≤ 2.4. One of the dwarf galaxies has a stellar mass of 6.6×10^7 $M_\odot$ and is the least massive galaxy found so far to host an AGN. Unlike massive galaxies, the AGN fraction of low-mass galaxies is found to decrease with redshift, suggesting that AGN in dwarf galaxies evolve differently than those in high-mass galaxies. The future large, deep, multiwavelength surveys that will result from the synergy of Athena with major optical/IR facilities will allow us to detect IMBHs in fainter (less massive) and more distant galaxies and thus to better understand how supermassive black holes in the early Universe formed.

Dust-to-gas ratio in a complete sample of AGN

Ignacio Ordovás Pascual (IFCA, CSIC-UC)

X4.3 – *Abstract:*
According to the Unified Model of Active Galactic Nuclei (AGN), an unobscured AGN based on the optical data (detection of rest-frame UV-optical broad emission lines, type-1 AGN) should appear as an X-ray unabsorbed AGN. However, there is an important fraction (10-30 %) of AGN whose optical and X-ray classifications do not match. It is not well known whether the material that absorbs the X-ray emission in these apparently discordant objects is the same that the one that obscures the optical emission, or if it has intrinsically different properties than the main population. To provide insight into this topic, we have conducted a statistical analysis of the optical obscuration and X-ray absorption properties of the 125 optically type-1 AGN from the Bright Ultra-hard XMM-Newton Survey (BUXS) in the $z = 0.05$-1 range and with $L_{2-10keV} > 42$ erg s^{-1}. All of these AGNs have high-quality spectra from XMM-Newton and either Sloan Digital Sky Survey spectra or proprietary observations. As BUXS is a flux limited ($f_{4,5-10KeV} \geq 6 \times 10^{-14}\,\mathrm{erg\,s^{-1}\,cm^{-2}}$) X-ray selected sample, it is complete for NH column densities up to the Compton-thick limit ($\sim 10^{24}\,\mathrm{cm^{-2}}$). In our works we have determined the impact of contamination from the AGN hosts galaxies in their optical classification. We derive the X-ray absorption by fitting their XMM-Newton spectra and the optical extinction using UV/optical spectral continuum fits. Most type-1 AGN in our sample show consistent optical and X-ray classification, but there is a large fraction (∼20 %) of objects with large N_H column densities ($N_H > 4 \times 10^{21}\,\mathrm{cm^{-2}}$). Our preliminary results shows that the majority (∼70 %) of the sources show dust-to-gas ratios compatible with the Galactic relation. Among the discordant dust-to-gas ratios we found both objects with more dust (∼13 %) than the Galactic relation and more gas (∼17 %) than the Galactic relation.

A Large Fraction of Rapidly-Growing Supermassive Black Holes Evade Census

Silvia Mateos (IFCA, CSIC-UC)

X4.4 – *Abstract:*
Dedicated searches suggest that the fraction of obscured Active Galactic Nuclei (AGN) decreases substantially with increasing luminosity. To explain these findings receding torus models have often been adopted. I shall present the results of a recent study where we determined the intrinsic fraction of optical type-2 AGN at $z < 1$ and X-ray luminosities from 10^{42} to $10^{45}\,\mathrm{erg\,s^{-1}}$. We used a complete X-ray selected sample of 199 AGN, from the Bright Ultrahard XMM-Newton Survey, and the distributions of covering factors of AGN tori derived from CLUMPY torus models. Since these distributions combined over the total AGN population need to match the intrinsic type-2 AGN fraction, we revealed a population of X-ray undetected objects with high-covering factor tori, which are increasingly numerous at higher AGN luminosities. When these "missing" objects are included, we found that Compton-thick AGN account at most for $\sim 35\,\%$ of the total population. The intrinsic type-2 AGN fraction is $\sim 58\,\%$ and has a weak, non-significant luminosity dependence. Our findings imply that the majority of luminous rapidly-accreting supermassive black holes at $z < 1$ reside in highly-obscured nuclear environments but most of them are so deeply embedded that they have so far escaped detection in X-rays in < 10 keV wide-area surveys.

IR Spectroscopic Tracers for (obscured) Galaxies: Synergies between SPICA and Athena

Juan Antonio Fernández-Ontiveros (IAC)

X4.5 – *Abstract:*
The rest-frame mid- to far-IR range contains a unique suite of spectral lines and dust features that allow us to determine the physical conditions in galaxies (e.g. density, ionisation, heavy element abundances) using tracers with a feeble response to both extinction and temperature. In this study we present a spectroscopic database of mid- to far-IR fine- structure lines observed with Spitzer/IRS and Herschel/PACS for a sample of 170 local AGN, 20 starburst galaxies, and 43 dwarf galaxies. The observations are compared to a set of Cloudy photoionisation models to estimate the physical quantities through the different diagnostic diagrams. The new [O IV]25.9μm/[O III]88μm vs. [Ne III]15.6μm/[Ne II]12.8μm diagram is proposed as the best diagnostic to separate: 1) AGN activity from any kind of star formation; and 2) low-metallicity dwarf galaxies from starburst galaxies. Chemical evolution studies can use the ([O III]52μm + [O III]88μm)/[N III]57μm or the ([Ne III]15.6μm + [Ne II]12.8μm)/([S IV]10.5μm + [S III] 18.7μm) ratios as promising metallicity tracers in obscured objects. The diagnostic power of mid- to far- IR spectroscopy shown here for local galaxies will be of crucial importance to study the galaxy evolution during the dust-obscured phase at the peak of the star formation and black-hole accretion activity ($1 < z < 4$). In this regard, Athena+ is expected to provide a large number of obscured AGN candidates at high-z, which could be then followed-up using a sensitive IR telescope as the SPace Infrared telescope for Cosmology and Astrophysics (SPICA). Specifically, the synergy between SPICA and Athena+ would allow us to address the problem of the "missing metals" in galaxies at high-z, and perform dust mineralogy studies in galaxies based on the analysis of IR spectroscopic features and the X-ray absorption edges produced by chemical elements trapped into dust grains.

The Compton-thick AGN fraction from the deepest X-ray spectroscopy in the CDF-S

Amalia Corral (IFCA, CSIC-UC)

X4.6 – *Abstract:*
Highly obscured AGN, especially Compton-thick (CT) AGN, likely play a key role in the galaxy-AGN co-evolution scenario. They would comprise the early stages of AGN activity, preceding the AGN-feedback/star-formation quenching phase, during which most of both the SMBH and galaxy growth take place. However, the actual CT fraction among the AGN population is still largely unconstrained. The most reliable way of confirming the obscured nature of an AGN is by X-ray spectroscopy, but very deep observations are needed to extend local analyses to larger distances. We will present the X- ray spectral analysis of the deepest X-ray data obtained to date, the almost 7Ms observation of the Chandra Deep Field South. The unprecedented depth of this survey allow us to carry out reliable spectral analyses down to faint fluxes in the hard 2-8 keV band. Besides the new deeper X-ray data, our approach also includes the implementation of Bayesian inference in the determination of the CT fraction. Our results favor X-ray background synthesis models which postulate a moderate fraction (25 %) of CT objects among the obscured AGN population. We also tested, by using simulations, how the spectral quality and the selection technique of CT candidates may affect these results.

Meeting Summary