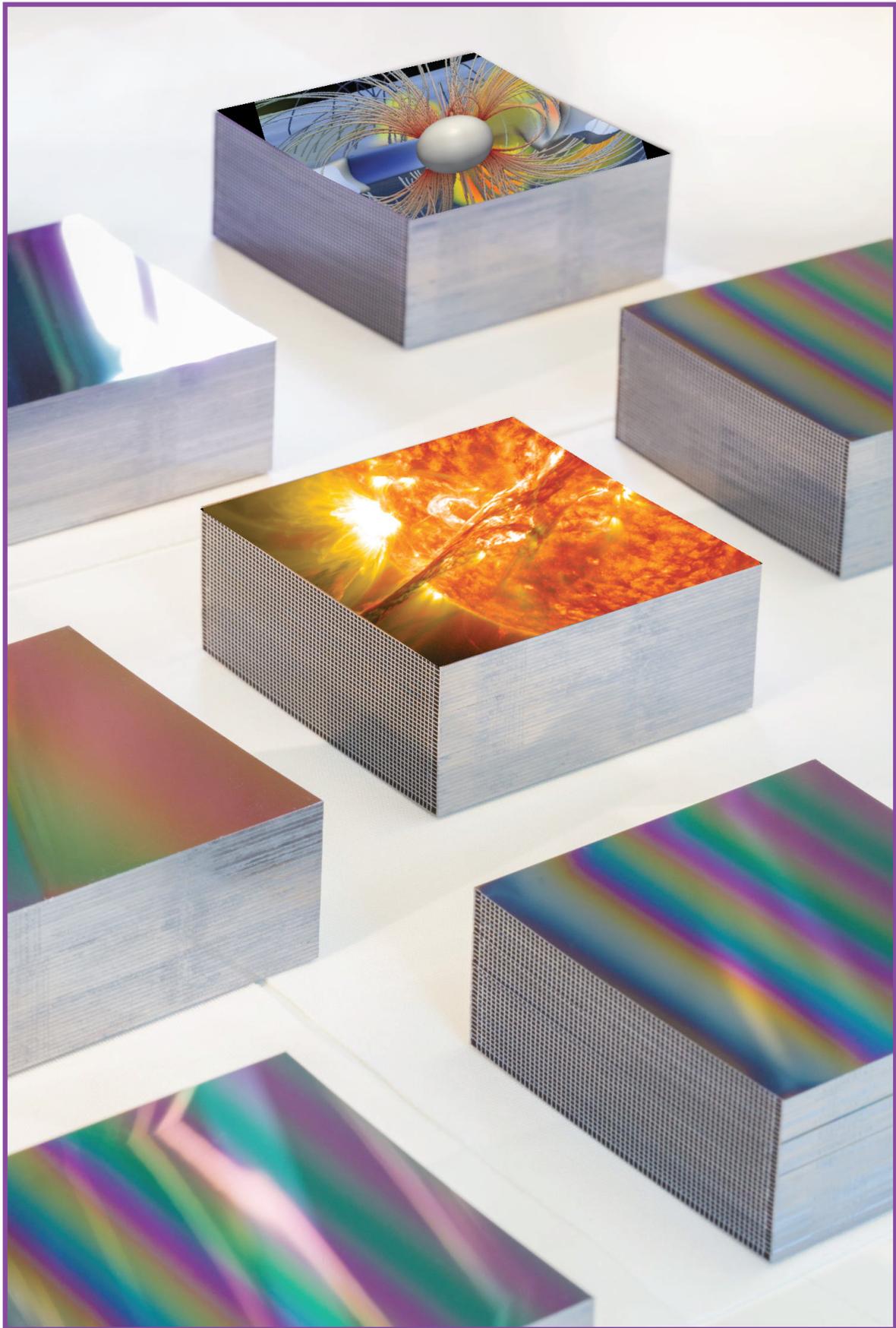


ATHENA: Community



Newsletter #5

June 2018

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Edited by *Athena* Community Office:

F.J. Carrera, M.T. Ceballos, S. Martínez-Núñez, M.P. Monterde

Instituto de Física de Cantabria (CSIC-UC)

Avda Los Castros s/n

39005 Santander (Spain)

<http://www.the-athena-x-ray-observatory.eu/>

✉ aco@ifca.unican.es

🐦 @athena2028

📘 The Athena X-ray Observatory

📺 Athena X-ray Observatory

Editorial Board: L. Piro & R. Smith

*Front Cover image credits: Background image: Silicon pore optics stacks (Credit: cosine Research/ESA). Middle image: on August 31, 2012 as a result of a flare a CME erupted out into space with a speed of over 1500 km/s and connected with Earth's magnetosphere, causing aurora (Credit NASA). Top image: 3D MHD simulation of flaring activity occurring close to a circumstellar disk around a rotating magnetized star (Credit S. Orlando).

Welcome

K. Nandra (ASST Lead Scientist) on behalf of the Athena Science Study Team (ASST)

Welcome to the latest edition of the *Athena* Community Newsletter.

This issue begins on a sad note, with a short article from Hideyo Kunieda about the pioneering work of Yasuo Tanaka, who unfortunately passed away earlier this year. His leadership and vision in X-ray astronomy has left a lasting legacy, being carried forward with missions such as Hitomi and *Athena*.

Along with the customary updates on progress with the project and instruments, our science highlight focusses on extreme stellar flares, similar but much more powerful versions of solar flares. Salvo Sciortino and Ignazio Pillitteri of Palermo Observatory outline how *Athena* will help us

understand these explosive events and their host stars.

Palermo will also be the venue for next major *Athena* conference. Please come and join us there from 24-27th September, where you might meet in person our featured *Athena* scientists: Andrea Comastri, Randall Smith and Nathalie Webb.

Last but not least, this issue marks the two year anniversary of the inauguration of the *Athena* Community Office. Thanks to Francisco, Silvia, Maite, Pilar, Didier, Arne and Enrico for their great work so far, and may it long continue.

Prof. Tanaka: a pioneer of X-ray astronomy

Hideyo Kunieda (Nagoya University)

Prof. Yasuo Tanaka passed away on January 18, 2018. His contributions to high energy astrophysics started balloon observations of cosmic electrons in the 1960's, when he stayed in the Netherlands to establish an astrophysics group there.

He was one of the pioneers of experimental approaches in space science. He was a leader of 20 balloon and 21 rocket, and 4 Japanese satellite experiments for X-ray astronomy. The highlight was the ASCA satellite (1993) equipped with high throughput X-ray telescopes and CCD and gas imaging spectrometers. Several of those were developed by international collaborations. His leadership and strong international network made it an epoch-making X-ray mission, followed by BeppoSAX in 1996 and by XMM-Newton and in 1999.

After his retirement, he moved to Munich in 1994 and was involved in the discussion about the next X-ray observatory mission concept for the 21st century. In Japan, an effort was started in the late 1990's to place a micro-calorimeter onboard a satellite to explore high resolution spectroscopy, according to Prof. Tanaka's recommendation. The first idea for the XEUS project was to discover the first generation

of supermassive black holes with an extremely large X-ray telescope of 10 m in diameter. Currently the *Athena* mission seems to be the combination of the large area X-ray telescope with the micro-calorimeter array. I am glad to find that the ideas and the spirit of the XEUS founders, like Prof. Tanaka, are still maintained in the *Athena* mission by its current leaders.



Yasuo Tanaka during the celebration of his 70th birthday at MPE. Credit: MPE

Athena Project Status

K. Nandra (MPE), D. Barret (IRAP) and M. Guainazzi (ESA) for the Athena Science Study Team

Athena continues to progress through Phase A. A key milestone passed in January, which saw the completion of the ESA Status Review 1 (SR1). This was an important and comprehensive review at system level, including technical, cost and schedule aspects, aimed at closing the industrial Phase A1. A review of the instrument status was not within the scope of SR1.

A number of cost-cutting measures were explored and implemented prior to and during SR1, including baselining of the smaller, 15-row mirror leading to a reduction of the effective area at 1 keV from 2m² to 1.4m². The ESA Study Team will continue to explore cost reduction options while proceeding with the nominal development of Phase A. The review confirmed that the 15-row mirror configuration is mass compliant with a high level of system margin (~30%). While SR1 formally marks the end of Phase A1, there will be a short (~6 month) extension to allow the industrial primes to develop a mission configuration and design with the smaller mirror.

In terms of schedule, the Mission Formulation Review (MFR) which ends Phase A, is currently scheduled for Q4 of 2019, while the Mission Adoption Review (MAR) is scheduled for late 2021. Prior to adoption a number of conditions must be achieved, including sufficient design maturity, critical technology developments, consolidation of partnerships and affordability. An intermediate checkpoint in terms of technology developments may already be implemented at MFR, to ensure the critical technologies are on track for adoption.

While the schedule to adoption is reasonably well consolidated, the subsequent phases are less certain. According to the SR1 assessment a number of activities are on the critical path for the implementation phase, including X-IFU development and integration onto the Science Instrument Module (SIM) and the mirror schedule. These considerations lead to a likely launch date in the early 2030s, but further work and optimization are needed to firm this up more precisely.

Important progress has been made in the

development of the instruments, reported elsewhere in this newsletter. At system level the focus is currently on the definition of the interfaces between the instruments and the SIM, responsibility for which is expected to be transferred back from ESA to the Industrial Primes in Sept 2018. The first major reviews of the instruments, the Instrument Preliminary Requirements Reviews (I-PRRs) are scheduled for the second half of 2018 and considered an important next step towards adoption.

To facilitate joint work between ESA and the instrument teams, a new Study Management Plan is being implemented. This includes the establishment of an *Athena* System Engineering (ASE) Board. This has had two meetings so far, and sessions in ESAs Concurrent Design Facility (CDF) to consolidate the SIM design continue at regular intervals.

ESA also recently initiated a process to recognize the *Athena* instrument consortia formally. A light process which avoids duplication with the I-PRR work is foreseen, and expected to be complete before the end of 2018.

In terms of scientific activities, the ASST and its working groups have undertaken a number of activities since the CORE exercise, the latter being a crucial input to SR1. In early January a meeting of SWG1 took place in Sesto/Sexten, Italy, and at which the Hot Universe science objectives and their implementation with *Athena* were discussed in detail. This has led to further work on the conditions for stray light requirements and its mitigation, following simulations based on the latest stray light model generated by the *Athena* Telescope Working Group. Work continues on various other aspects of the science requirements document, including some matters arising from SR1 such as the absolute astrometric requirements.

The next major scientific activity for the ASST is the so-called “science sensitivity” analysis. This stemmed initially from a recommendation from the ESA Study Team for the ASST to look at certain critical *Athena* performance parameters and make an assessment of the sensitivity of the science objectives

to these parameters. A similar approach was endorsed by SR1, who recommended considering a “tolerance” for certain requirements. The key issue is that of compatibility of the demonstrated performance with respect to the requirements at the time of MFR. The ASST will soon start analysis of the first of these parameters, the mirror angular resolution, with the intention of reporting back to the study team at the next ASST meeting.

The ASST will hold its next meeting on July 3-4th

at ESTEC, at which one of the major topics is expected to be the status of the SPO optics developments, and in particular of the on-going activity to improve the angular resolution.

We look forward also to seeing you at the *Athena* conference in Palermo, to be held from 24-28th September, at which we expect to report in more detail on the mission and instrument status, science and synergy with other major facilities operating in a similar timeframe.

We look forward to seeing you at the
"Exploring the Hot and Energetic Universe"
on page 06!



Members of Science Working Group 1 met in Sesto/Sexten, for a discussion of the *Athena* Hot Universe science objectives

News from the Instruments

News from the WFI

A. Rau (MPE, WFI Project Scientist) and K. Nandra (MPE, WFI Principal Investigator)

The WFI development progresses on all fronts, with the consortium working with full force towards the next two important milestones for the instrument. The Instrument Preliminary Requirements Review (I-PRR) scheduled for Autumn 2018 will mark the conclusion of the concept and feasibility study. The Instrument Preliminary Design Review (I-PDR) due in Summer 2019 will kick-off the development of the WFI engineering model, which will match the final flight model in form, fit, and function albeit not requiring flight-grade hardware components.

Where do we stand with the three critical WFI technology development activities?

On the detector side, the pre-flight DEPFET production at the Semiconductor Laboratory of the Max Planck Society started in Autumn 2017 and will continue until the end of 2018. This production run includes flight-size and flight-like 512x512 pixel sensors for the Large Detector Array as well as the next iteration of 64x64 pixel devices for the Fast Detector.

The detector electronics development has taken an important step with the fabrication of its breadboard. As an interesting side note, the term 'breadboard' comes from the early 1900s when experimentalists literally used their wooden boards

intended for cutting bread as cheap, and readily available platforms for their electronics projects. Our breadboards are of course no longer made of wood but use space-qualified components (or counterparts thereof) to demonstrate the required technical readiness level by verifying the performance of the detector electronics in realtime. In addition to all the dynamic signals, this includes the realtime data pre-processing (e.g., the offset correction, bad pixel elimination, common mode correction, and event reconstruction). With more than 50 Mega pixel/s per quadrant of the Large Detector Array, this corresponds to a data rate of approx. 18 Gbit/s for each of the detector electronic chains, which need to be processed and turned into event lists.

The development of the filters was already described in the recent *Athena Nugget #23*. The filter and filter wheel, all other subsystems, as well as the project and science activities, were also discussed during the 7th WFI Consortium. The very successful meeting was held at the Max Planck Institute for Extraterrestrial Physics in Garching, April 17th-19th with more than 85 participants from all consortium partner institutions, plus additional guests. The next consortium meeting is planned for November, in Lisbon, Portugal.



SEVENTH WFI CONSORTIUM MEETING. APRIL 17-19.
MPE GARCHING (MUNICH, GERMANY)

News from the X-IFU

A stable baseline configuration for the X-IFU

D. Barret (IRAP, X-IFU Principal Investigator) and T. Lam Trong (CNES, X-IFU Project Manager)

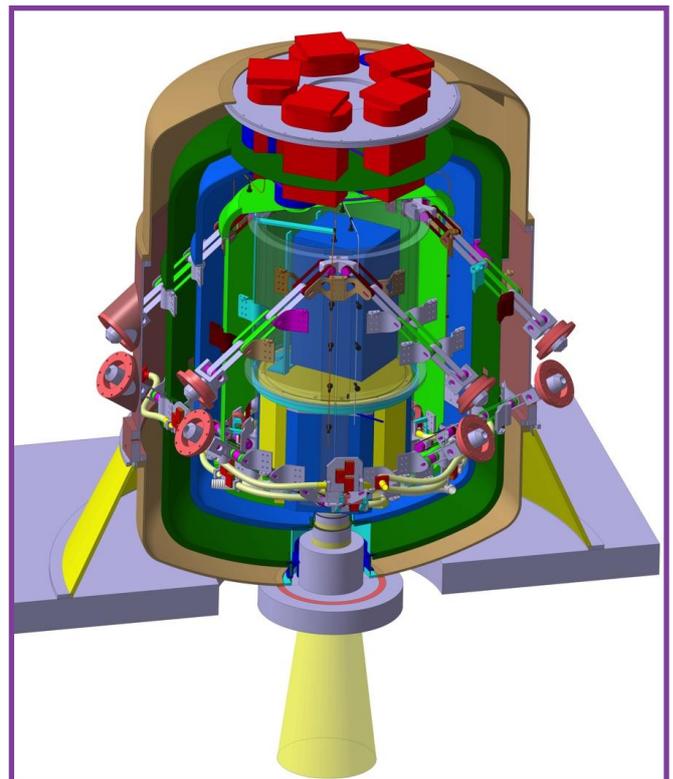
The X-IFU Consortium meeting #7 was held at the Astroparticle and Cosmology Institute in Paris from March 19-24. More than 140 X-IFU Consortium members, engineers and scientists, gathered to discuss on-going activities related to the development of the instrument. During the plenary sessions, the revised X-IFU baseline configuration was presented in detail. The main changes compared to the previous configuration follow from the assumption of a 200 K temperature for the Dewar outer vessel and a refined estimate of the 2K dissipation. This enabled the thermal budgets at all temperature stages to have the requested 30% margins, even in the worse case of the failure of a 2K Joule Thomson (JT) cooler.

The cryogenic chain thus remains based on five 15K Pulse Tubes (PT), two 4K JT, two 2K JT and a last stage sorption-ADR. The top-level performance requirements are preserved with the new baseline, most notably the numbers of readout chains (still 96), thereby maintaining the field of view. Pursuing an aggressive design-to-mass approach, the mechanical interfaces of the Dewar have been revisited, and revised mass allocations to driving subsystems have been agreed. This led to a revised mass budget for the X-IFU, and a small non-compliance of less than 25 kg. Mitigating micro-vibrations remains a priority and options to remove the compressors of the 15 K PT are being investigated. Specifications to key subsystems are now being iterated, still subject to optimization in terms of performance and mechanical accommodation (e.g. filters, MXS, filter wheel...).

The avionic architecture, with the power distribution unit, the instrument control unit, the housekeeping management units, and the harnesses has already reached a satisfactory level of definition. Interfaces of the X-IFU with the Science Instrument Module (SIM) have yet to be studied in detail, as part of the global mechanical and thermal optimization of the SIM (e.g. thermal control system, mechanical structure, warm harness routing). This activity will be steered by the *Athena* system engineering board, which is supported by the X-IFU team. The consolidation of the baseline configuration of the

X-IFU is now the prime focus of the team's activities, involving the optimization of some key components entering the overall instrument performance, e.g. the design parameters of the transition edge sensors.

The consolidated baseline will be presented at the Integrated Progress Meeting #4 to be held at CNES (June 27-28), after which it will be temporarily frozen to produce the data-pack for the X-IFU Preliminary Requirement Review to be held mid-December. In parallel, the X-IFU consortium is getting ready to respond to ESA, which is expected to formalize the *Athena* payload consortia over the summer.



The X-IFU Dewar assembly presented at the X-IFU Consortium Meeting #7. The outer shell of the cryostat (in maroon) is now assumed to be cooled off passively at 200 K, providing support to the cryogenic chain. The outer struts supporting the Dewar have been replaced by a conical structure to save mass (shown in yellow).

Exploring the Hot and Energetic Universe

The second scientific conference dedicated to the Athena X-ray observatory , 24-27 September 2018, Palermo, Italy (<http://www.astropa.inaf.it/athena18/>)

L. Piro (Istituto Astrofisica e Planetologia Spaziali, Italy)

This 2nd conference on *Athena* will give the opportunity to discuss with the astrophysical community its prospective scientific impact, and its role in the context of multi-wavelength and multi-messenger facilities that will be operational at the end of the next decade.

The conference will encompass five broad topics. A general overview on the mission will provide an updated description of the key elements of the mission, including instruments and optics and the status of Phase A activities.

The session on the Hot Universe will address the large-scale structures in the Universe and will review the *Athena* science impact on the study of cosmological filaments, clusters and groups of galaxies and their evolution, the missing baryons and the warm-hot intergalactic medium.

The Energetic Universe session will touch upon the growth of supermassive black holes, the mechanisms at the core of the central engine, and their influence, through the feedback effect of accretion, on the formation and evolution of galaxies. Feedback effects of the accretion on the low mass black holes will also be a topic of this session. The capability of *Athena* in reaching out the high-redshift universe with Active Galactic Nuclei and Gamma Ray Bursts will be discussed.

The origin, nature and effects of high energy emission on a wide range of interesting astrophysical sources and phenomena will be reviewed: Solar System Bodies, Exoplanets, Star Formation and Evolution, Supernova Remnants and the Interstellar Medium, Star Formation and the Star Formation History of the Universe, End Points of Stellar Evolution as well as the synergies between X-ray and Gamma-ray Observations of Cosmic Particle Accelerators.

Various talks will discuss the synergies between *Athena* and ground/space based future facilities such as ELT, ALMA, SKA, CTA and other ground and space observatories likely to be in operation simultaneously to *Athena*. Moreover, the synergy of *Athena* with facilities carrying out large sky surveys at various frequencies, including GRBs, will be addressed. The capabilities of *Athena* in the rapidly growing subject of the multi-messenger astronomy to find, characterize and study the physical processes at work in the electromagnetic counterparts of gravitational waves sources detected by the evolution of LIGO and VIRGO experiments on the ground and LISA in space will be discussed.

Finally, the role of possible future X-ray missions (eROSITA, XARM, ...) will be also presented.



The Fast and the Furious: extreme stellar flares

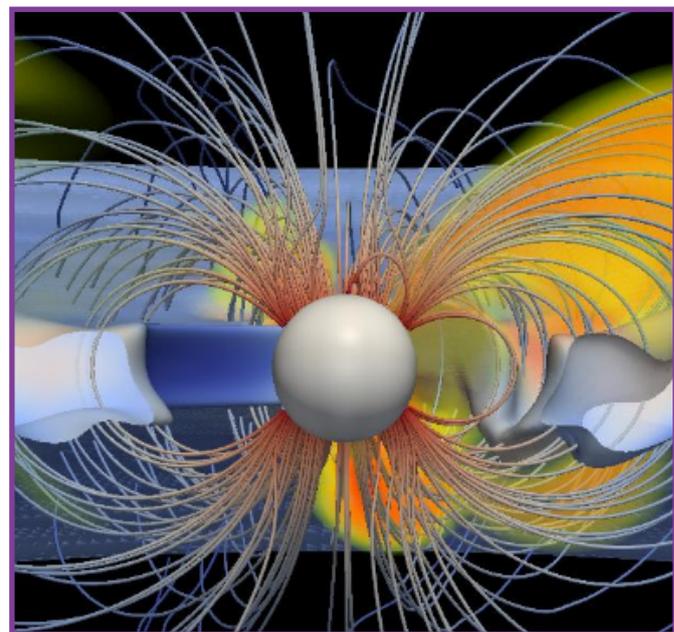
S. Sciortino and Ignazio Pillitteri (INAF-Osservatorio Astronomico di Palermo, Palermo, Italy)

Since the '80s, X-ray images have shown that other stars possess a “corona” like the Sun. The corona is the outer part of the stellar atmosphere, where very hot and ionized gas, called plasma, is shaped by the stellar magnetic field. In such conditions the corona emits a lot of X-rays. For the typical coronal temperatures this emission is largely (> 70%) dominated by a forest of lines whose presence and intensity trace the abundances of major chemical elements and coronal temperatures, respectively.

Abrupt and erratic changes of the configuration of the magnetic field produce recurrent reconnection of the field lines and release of energy in form of flares, i.e. very rapid increases of stellar emission that are visible at all wavelengths. In the Sun the flares sometimes are accompanied by the expulsion of a blob of plasma: this phenomenon is a Coronal Mass Ejection (CME). Coronal emission is stronger and hotter among stars more active and/or younger than the Sun. Such active stars often host extreme flares that can release up to 100.000 times more energy than the one of the strongest known solar flares. To date the available evidence of stellar CMEs is very sparse and limited at best. Various pieces of evidence indicate the crucial role of coronal emission (and associated flares) during the early evolution of our protoplanetary system and subsequently on Earth's atmosphere. We have records of some major effect of rather small CMEs on our complex society (e.g. the Carrington event, 1859, the power blackout in North America on 1977).

Athena's sensitive spectrometers will unambiguously determine the presence of a CME contemporaneous with an X-ray flare by tracing the shift of the emission line centroids due to the hundreds km/s velocity of the plasma at the flare onset. This will allow us i) to trace the motions and changes of abundances due to matter evaporating from the stellar chromosphere and/or ii) to find evidence of CMEs and determine their key physical parameters (mass, velocity, energy, etc.). In the case of a young star still accreting matter from its circumstellar disk, *Athena's* time-resolved spectral study of extreme flares will expose in detail any

oscillation of the X-ray emission. This phenomenon has been recently discovered in a few bright flares. With *Athena* we will gain knowledge about the complex interplay of the magnetized corona and the inner circumstellar disk in very young stars, a phenomenon that manifests itself in long lasting powerful flares perturbing the inner disk.



Top: On August 31, 2012 as a result of a flare a CME erupted out into space with a speed of over 1500 km/s and connected with Earth's magnetosphere, causing aurorae. Credit: NASA.

Bottom: 3D MHD (Magneto Hydro Dynamic) simulation of flaring activity occurring close to a circumstellar disk around a rotating magnetized star. The flaring activity gives rise to hot magnetic structures linking the disc to the star and strongly perturbs the disc, whose material evaporates under the effect of the thermal conduction while overpressure waves propagate through the disc. Credit: S. Orlando.

ACO: two years on duty

ACO Team

On June 22nd 2016, the *Athena* Community Office (ACO) began its journey as 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.

Every week we update the *Athena* community web portal with relevant news and resources for the community, such as templates for your presentations, standard presentations and relevant publications.

The **Community section** has been recently updated to include the short professional profiles of several members and a map where you can find the different institutions and people who belong to our global community. Look for yourself on the map, and tell us if there is any issue.

One of the key elements to disseminate the project are the *Athena Nuggets*, covering various scientific and technical topics relevant to *Athena*, both with short write-ups and slides ready to be used in talks and lectures. If you'd like to discuss the future of X-ray astronomy in your next talk, check out our nuggets for the topics which are available already.

In terms of outreaching the *Athena* project, the office has developed some material, joining the European Researcher's Nights and the International Day of Women and Girls in Science in the last two editions. Feel free to use the outreach material in your

local events downloading them from the “**Outreach/Material**” section of the web portal, and if you do so, please inform us.

The office is supporting the publication of a series of White Papers on synergies of the mission with other large astronomical facilities. The papers are available in the “**Overview Papers**” section of the web after publication in arXiv.

A major milestone has been the update of the *Athena* community database to include new members from the yearly call, and recently to adapt to the new EU data protection regulation. The primary responsibility for their personal data relies in each member of the Community so, please, let us know of any changes on your data (email, affiliation...).

Don't forget to keep up-to-date on our latest news following the web portal or the social channels (@athena2028 and @athena.xray.observatory), and feel free to become an active part of the dissemination of the project by re-posting!

These activities are only possible thanks to the support and inputs received from all of you and we need your help to keep promoting *Athena*. So, if you publish any paper or give a presentation of interest to the community, please let us know by filling the corresponding forms (**paper** and **conference**). And of course, new ideas are always welcome!



Athena Community People

Andrea Comastri

andrea.comastri@oabo.inaf.it



Andrea is an X-ray astronomer and currently the Director of the Astrophysical and Space Science Observatory of the National Institute of Astrophysics in Bologna, Italy.

Over his career he has worked on the X-ray observations of Active Galactic Nuclei and population synthesis models for the X-ray background.

He has been deeply involved in most of the X-ray surveys carried over by several missions and the follow up multiwavelength observations performed with both ground and space based observatories.

The present scientific activity is concentrated on the search for and the characterization of highly obscured, Compton thick AGN in ultra-deep X-ray surveys and the nature of the first accreting sources in the early ($z > 6$) Universe.

Andrea is a co chair of the Topical Panel on high redshift AGN and member of the WFI Science Team and Consortium Board.

Randall Smith

rsmith@cfa.harvard.edu



Randall began his career studying the physics of the interstellar medium (ISM) at the University of Wisconsin-Madison. While there, he developed an interest in X-ray satellites, working to develop two proposals for X-ray microcalorimeter missions that eventually helped motivate US participation in the Suzaku and Hitomi missions. He is currently a Senior Astrophysicist at the Harvard-Smithsonian Center for Astrophysics, and has also spent a number of years working at the NASA/Goddard Space Flight Center.

His primary focus today is as PI of the proposed Arcus X-ray satellite, an X-ray grating spectrometry mission that would provide high-resolution spectra in the soft (12-50Å) bandpass. He also leads a group focused on collecting atomic data for X-ray spectroscopy (AtomDB).

On *Athena*, Randall is the US member of the *Athena* Science Study Team and co-chair of the Observatory Science Working Group, which covers a range of sources from the solar system, stars, supernova remnants, and - returning to his original interests - the ISM. He plans to use *Athena* to study how supernova remnants affect gas and dust in the ISM.

Natalie Webb

Natalie.Webb@irap.omp.eu



Natalie is a multi-wavelength astronomer at the Institut de Recherche en Astrophysique et Planétologie (IRAP), Toulouse, France, where she is head of department and head of the Masters degree “Astrophysics, Space and Planetary Science”. She is also head of the XMM-*Newton* Survey Science Centre.

Natalie’s research is focussed on the origin and the growth of supermassive black holes seeds, and on constraining the nature of the supra-dense matter inside neutron stars.

As project scientist for the *Athena*/X-IFU Instrument Science Center (X-ISC), she is putting together the infra-structure to provide stream-lined, robust and innovative software to enable the X-ray community to exploit the ground-breaking data that will come from the X-IFU.

Building on the experience garnered from XMM-*Newton*, data from *Athena* will revolutionise our view of the hot and energetic Universe!

AHEAD Announcement of Opportunity Cycle 6

The AHEAD (Integrated Activities for High Energy Astrophysics) project solicits proposals for its program of transnational visits. Three calls are included in this AO. The types of visit on offer are:

- » Experimental facilities: free access to some of the best European ground test and calibration facilities relevant for high-energy astrophysics.
- » Research visits: funding to support research visits for scientists and engineers to foster new or strengthen existing collaborations.
- » Data analysis: free access to training in the use of X-ray and gamma-ray data via tutorials and mentoring at host institutes.

Visitor grants include full reimbursement of travel and subsistence expenses.

#AO-6 Calls Opening → 15 May 2018

#Submission Deadline → 30 June 2018

Further information on the AHEAD website.

Conferences (July-December 2018)

Athena in Conferences

- French Society of Astronomy & Astrophysics (SF2A) week, Bordeaux (France), 3-6 Jul 18.
- Multiphase AGN Feeding and Feedback, Sexten (Italy), 9-13 July.
- 42nd COSPAR Scientific Assembly, Pasadena (USA), 14-22 July.
- XIII Biannual Meeting of the Spanish Astronomical Society, Salamanca (Spain), 16-20 July.
- Are AGN special? The environmental dependence and global impact of AGN activity, Durham (UK), 30 July - 2 August.
- Warm and Hot Baryonic Matter in the Cosmos: A Focus Meeting at the 2018 IAU General Assembly, Vienna (Austria), 20-31 August.
- The role of feedback in galaxy formation: from small-scale winds to large-scale outflows, Postdam (Germany), 3-7 September.
- Exploring the Hot and Energetic Universe: The second scientific conference dedicated to the Athena X-ray observatory, 24-27 September 2018, Palermo, Italy.
- Breaking the limits II - Super Eddington Accretion onto Compact Objects, Castiadas (Italy), 1-5 October.
- X-ray astronomy and fundamental physics, Buckinghamshire (UK), 24-25 October.

Coming conferences of interest

- The Laws of Star Formation: from the Cosmic Dawn to the Present Universe, Cambridge (UK), 2-6 July.
- The early growth of supermassive black holes, Sexten(Italy), 2-7 July.
- The Near, The Far, and the In-between: Synergy between low and high redshift galaxy evolution studies in the era of JWST and EUCLID, ESTEC (NetherLands), 23-27 July.
- X-ray Skies with High-Res Eyes: Imaging the Cosmos with AXIS, Washington (USA), 6-7 August.
- Chandra Science Workshop on Accretion, Cambridge (USA), 8-10 August.
- Birth, life and fate of massive galaxies and their central beating heart, Favignana Island (Italy), 3-7 September.
- International Workshop on Astronomy and Relativistic Astrophysics 2018, Lima (Peru), 9-15 September.
- Eighth International Fermi Symposium: Celebrating 10 Years of Fermi, Baltimore (USA), 14-19 October.
- Astronomical Data Analysis Systems & Software 2018, Maryland (USA), 8-11 November.