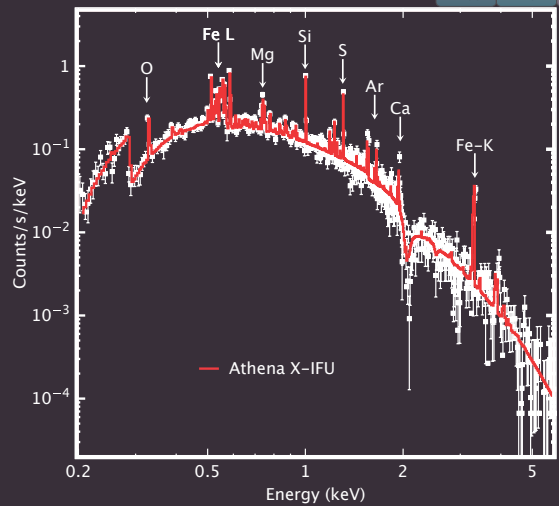
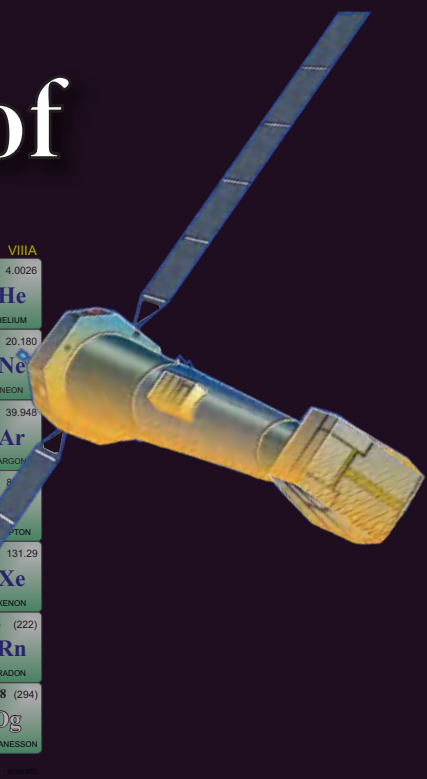
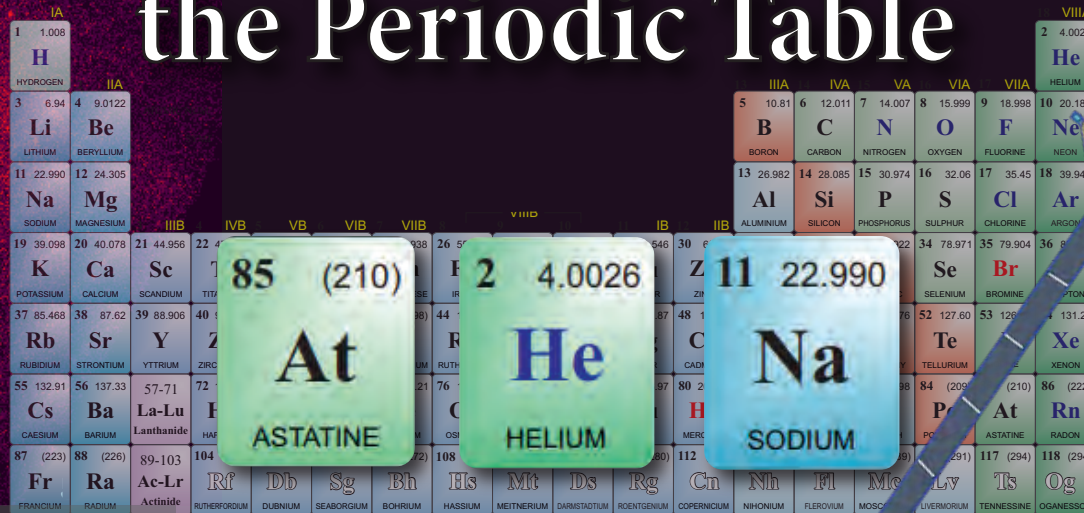
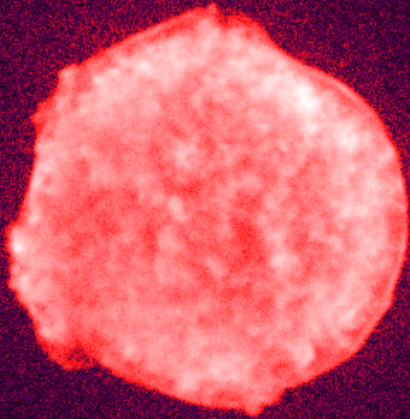


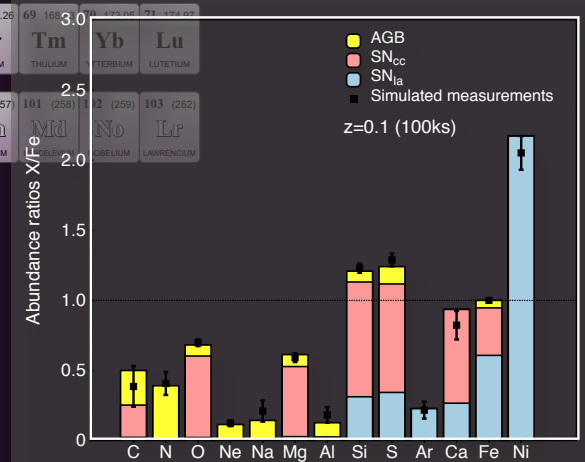
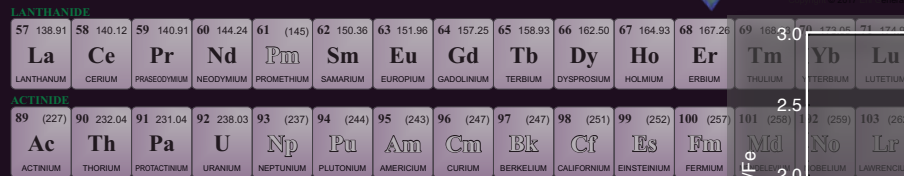
2019

The International Year of the Periodic Table

Credit: WFI Team



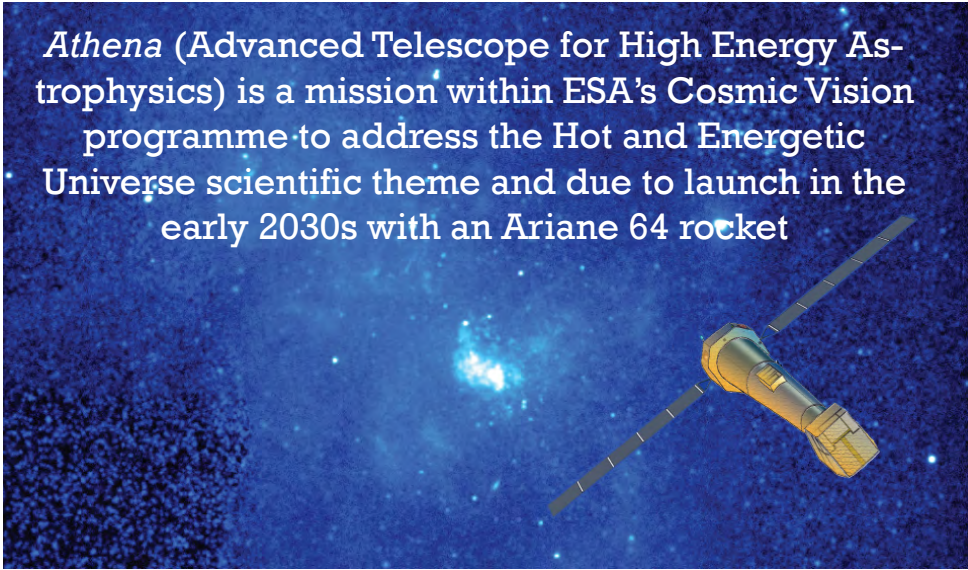
Credit: Barret et al. 2016, SPIE



Credit: Cucchetti et al. 2018

ATHENA

Athena (Advanced Telescope for High Energy Astrophysics) is a mission within ESA's Cosmic Vision programme to address the Hot and Energetic Universe scientific theme and due to launch in the early 2030s with an Ariane 64 rocket



INSTRUMENTATION

Athena will consist of a large-aperture X-ray telescope with two focal-plane instruments: the Wide Field Imager (WFI) providing sensitive wide field imaging and spectroscopy and high count-rate capability and the X-ray Integral Field Unit (X-IFU) delivering spatially resolved high-resolution X-ray spectroscopy

Athena will study how ordinary matter assembles into groups and clusters of galaxies, determine its chemical enrichment across cosmic time, and characterise the missing baryons residing in intergalactic filamentary structures

Athena will study the physics of accretion into compact objects, find the earliest accreting super-massive black holes and trace their growth even when in very obscured environments, and show how they influence the evolution of galaxies and clusters through feedback processes

Athena will have a fast target of opportunity observational capability, enabling studies of transient phenomena

As an observatory, *Athena* will offer vital information on high-energy phenomena on all classes of astrophysical objects, from solar system bodies to the most distant objects known

With its unparalleled capabilities, *Athena* will be a truly transformational observatory, operating in synergy with other large facilities in the early 2030s (ALMA, ELT, SKA, LSST, CTA, LISA, etc)

2019 Calendar



JANUARY



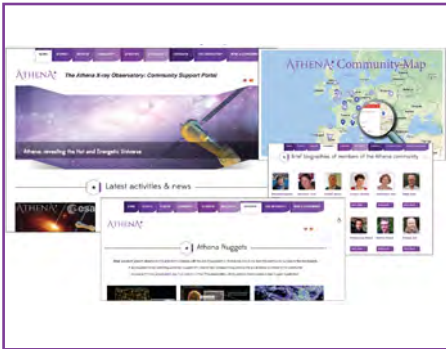
FEBRUARY



MARCH



APRIL



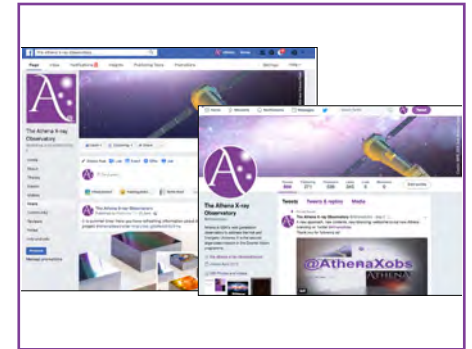
MAY



JUNE



JULY



AUGUST



SEPTEMBER



OCTOBER



NOVEMBER



DECEMBER

Athena Community Office



The *Athena Community Office* starts every year with a new calendar. In 2017 it was dedicated to *Athena* images, simulations and compositions, 2018 was focused on the images associated with the *Athena* nuggets and this year 2019, International Year of the Periodic Table, our outreach and dissemination activities decorate the calendar pages.



JANUARY 2019



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FEBRUARY 2019

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Day of Women and Girls in Science

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SCANDIUM

Every year, the *Athena* Community joins the International Day of Women and Girls in Science, an initiative of the United Nations to encourage and support girls and women to their full potential as scientific researchers and innovators. Stay tuned to our website and social media to discover what we have prepared for the 2019 celebration!



**Athena at the
International Day of Women and Girls in Science
11 February**

FEBRUARY 2019

ATHENA

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JANUARY 2019

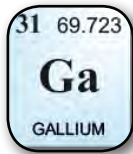
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MARCH 2019

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Athena Board Game



The *Athena* board game, created by Yaël Nazé with the support of IRAP and the collaboration of the ACO, is an outreach resource to explain how the *Athena* Observatory will solve a scientific riddle, starting with the submission of a proposal and ending with the publication of the results. The game is available in four different languages: [English](#), [French](#), [German](#) and [Spanish](#) and it is distributed under Creative Commons (CC BY-NC-ND) licence.



MARCH 2019



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APRIL 2019

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Fact Sheet and Leaflet

Athena Community Office has edited a fact sheet and a leaflet summarising the Athena mission goals and its unprecedented capabilities. You can find them on the Athena Community website under [Resources/Athena Brand](#). Feel free to use them!



OBSERVATORY
 Single X-ray Large Area Telescope with two instruments: Wide-Field Imager and X-ray Integral Field Unit

MIRROR
 Large-aperture grazing-incidence telescope, utilizing a novel high-performance Silicon pore optics technology developed in Europe.

The 12m focal length Athena mirror will deliver unprecedented effective area with excellent spatial resolution and a large field of view, all with very light weight. The telescope changes focus between two instruments.

Technology	Silicon Pore Optics
Effective area at 1 keV	14 m ²
Effective area at 6 keV	0.25 m ²
Spatial Resolution (Half Energy Width @ 2keV)	9 arcsec on axis, 10 arcsec off axis

WIDE FIELD IMAGER (WFI)
 Providing sensitive wide field imaging and spectroscopy and high count-rate capability with a 40°x40° field of view.

The WFI detector is based on Silicon DEPFET Active Pixel Sensor technology. The large field of view is achieved via a focal plane composed of several detectors: a larger detector array for wide-field observations and a smaller fast readout detector for very bright targets.

Technology	DEPFET Active Pixel Sensor
Spectral resolution	100 eV
Field of View	40 arcmin x 40 arcmin
Pixel size	2.2 arcsec
Time resolution	80 µs

X-RAY INTEGRAL FIELD UNIT (X-IFU)
 Delivering spatially-resolved high-resolution X-ray spectroscopy over a field of view of 5° effective diameter.

The X-IFU is a cryogenic X-ray spectrometer, based on a large array of Transition Edge Sensors, providing both spatially-resolved high spectral resolution and high count-rate capability with the optics defocused.

Technology	Transition Edge Sensor (TES)
Spectral resolution	2.5 eV
Field of View	5 arcmin diameter
Pixel size	1.5 arcsec
Time resolution	10 µs

ATHENA
FACT SHEET
 THE HOT AND ENERGIC UNIVERSE
 SCIENCE THEME

OBSEIVE X-RAYS FROM ASTRONOMICAL SOURCES

WIDE FIELD IMAGER (WFI)

X-RAY INTEGRAL FIELD UNIT (X-IFU)

APRIL 2019



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MARCH 2019

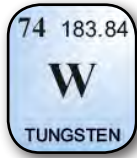
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MAY 2019

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Athena Website



The website (www.the-athena-x-ray-observatory.eu) contains updated information and resources to help and support the *Athena* community: activities, news and conferences, factsheet, leaflet and logo, standard presentations, newsletters, conference presentations, publications, simulation tools, outreach material and a link to the document repository.

The screenshot displays the Athena website interface. At the top, a navigation menu includes: HOME, SCIENCE, MISSION, COMMUNITY, ACTIVITIES, RESOURCES, OUTREACH, DOC REPOSITORY, and NEWS & CONFERENCE. Below the menu is a banner for "ATHENA: The Athena X-ray Observatory: Community Support Portal" featuring an image of the satellite in space with the text "Athena: revealing the Hot and Energetic Universe". To the right is a "ATHENA: Community Map" showing a map of Europe with location markers and a magnifying glass. Below the map is a section titled "Brief biographies of members of the Athena community" with a grid of member photos and names: Branduardi-Raymont, Brenneman, Laura, Comastri, Andrea, Combes, Françoise, Decourchelle, Anne, Fabian, Andy, Pointecouteau, Etienne, Reiprich, Thomas, and Schwobe, Axel. Each member entry includes a "READ MORE +" button. Below this is a section for "Athena Nuggets" with a sub-header "Latest activities & news" and a brief description: "Small pieces of wisdom about scientific and technical topics with the aim of approaching Athena not only to the scientific community but also to the non-experts. A single presentation collecting published nuggets with links to their corresponding posts in the social media is offered to the community in several formats: power point, key note and libre office. This presentation will be updated monthly once a new nugget is published." At the bottom, there are three thumbnail images representing different nugget presentations.

MAY 2019



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APRIL 2019

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JUNE 2019

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Athena Newsletter

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The *Athena Newsletter* is published every 6 months to keep the scientific community informed about ongoing activities, news and updates of the project. It starts with the mission PI welcome and the project and instruments status and run through the fixed sections of scientific/technical nugget(s), *Athena Community People* and forthcoming conferences.



JUNE 2019



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MAY 2019

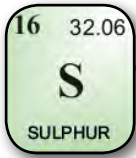
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JULY 2019

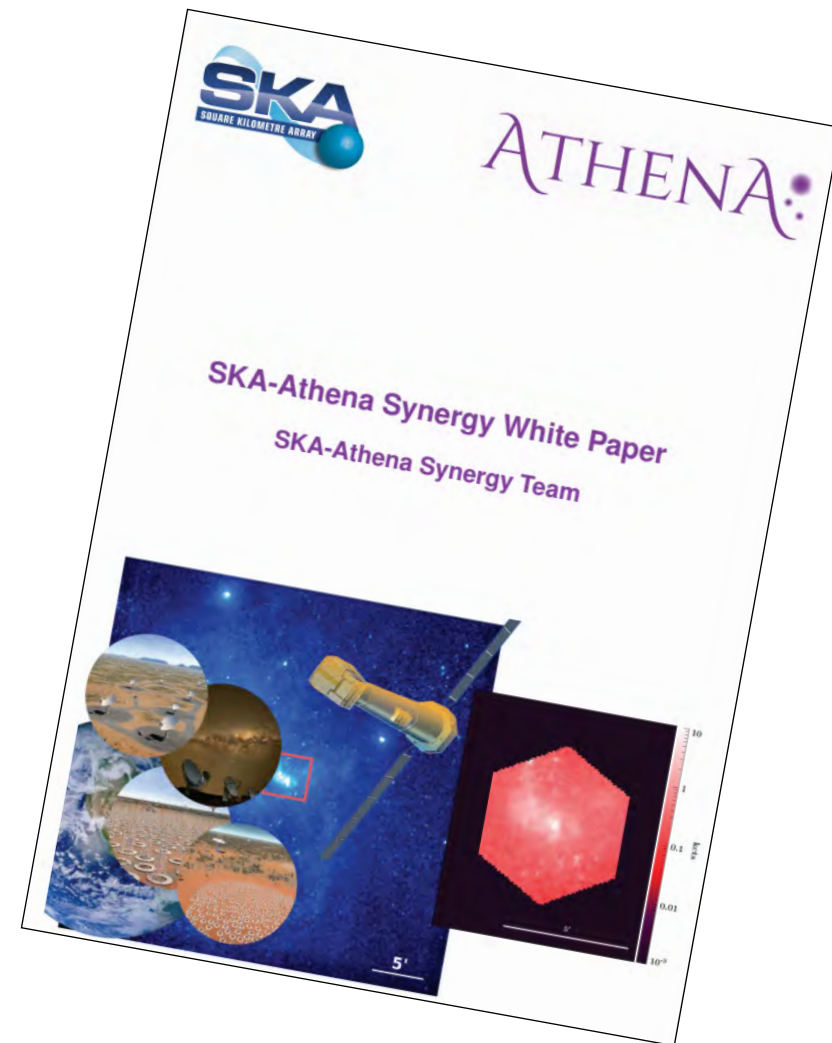
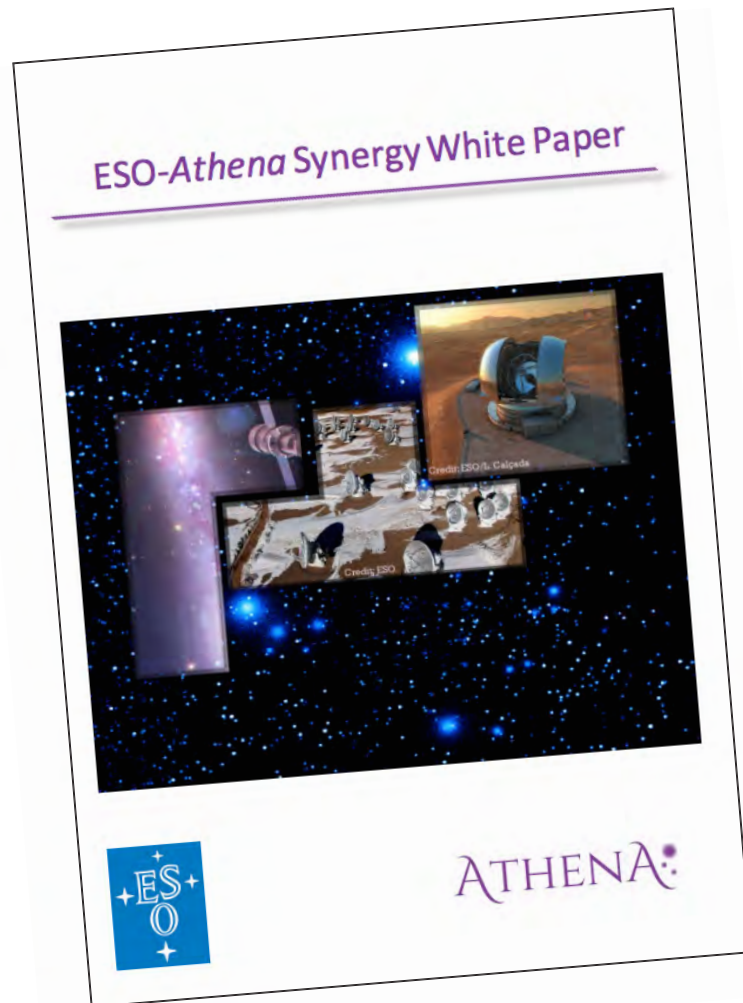
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Athena Synergies



The *Athena* Community Office has edited two White Papers summarising the synergies between *Athena* and two facilities of a unique set of astronomical observatories in the early 2030s: one with ESO Optical and near-IR (ELT, VLT, ...) and millimeter/submillimeter (ALMA, ...) coordinated by P. Padovani (arXiv:1705.06064) and another one with SKA coordinated by R. Cassano (arXiv:1807.09080). Additional Synergy Exercises are starting and planned with large-area surveyors and gamma-ray/multi-messenger facilities.



JULY 2019



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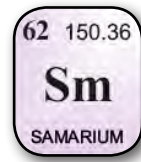
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AUGUST 2019

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Athena Social Media



Are you a media lover? Follow us on Twitter and Facebook where we post weekly news about the project and the ACO activities.

 [@AthenaXobs](https://twitter.com/AthenaXobs)

 [The Athena X-ray Observatory](https://www.facebook.com/TheAthenaXrayObservatory)

The image shows two overlapping social media profiles for the Athena X-ray Observatory. The background is the Facebook page, and the foreground is the Twitter profile.

Facebook Profile (Background):

- Page name: The Athena X-ray Observatory
- Profile picture: A large white letter 'A' on a purple background.
- Username: @athena.xray.observatory
- Navigation menu: Home, About, Photos, Events, Videos, Posts, Community, Reviews, Notes, Info and ads, Promote, Manage promotions.
- Post: "It is summer time! Here you have refreshing information about ACO project #AthenaNewsletter http://ow.ly/XMKn30kzXYw"

Twitter Profile (Foreground):

- Profile picture: A purple circle with a white letter 'A'.
- Stats: 504 Tweets, 271 Following, 526 Followers, 343 Likes, 0 Lists, 0 Moments.
- Header: Tweets, Tweets & replies, Media.
- Pinned Tweet: "A new approach, new contents, new branding: welcome to our new Athena branding on Twitter @AthenaXobs Thank you for following us!"
- Media: A GIF showing the Athena X-ray Observatory branding, including the text "@AthenaXobs" and "ATHENA".

AUGUST 2019



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JULY 2019

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SEPTEMBER 2019

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European Researchers Night

Every September, the Athena Community Office brings Athena to the streets of Santander (Spain) where the ACO is based. Last year, visitors could watch the premiere of the VR film “The X-ray Universe VR edition”, funded by the AHEAD EU project in a joint initiative with the PO of ACO. The X-ray Universe was also present through different activities: astronomical images of emblematic objects seen in X-rays and in other wavelengths or in B&W to be coloured by kids, and Kahoot games to be played by the visitors with their smartphones.



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AUGUST 2019

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OCTOBER 2019

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2nd Athena Conference



For the second conference dedicated to *Athena* celebrated in Palermo in September last year, the ACO created some merchandising materials that were distributed to the conference participants. Don't worry if you were not there...there will be more opportunities to get your pen, sticker or pen-drive with the *Athena* brand logos.



OCTOBER 2019



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NOVEMBER 2019

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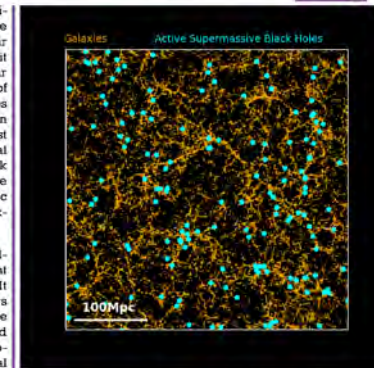
Not only for the scientific community but also for the non-expert science-interested public, the *Athena* nuggets are perfect to learn about the science that will be done with *Athena* and about the technology behind such an amazing mission. They are available on the [Athena website](#).

Connecting supermassive black-holes with the cosmic web

Antonis Georgakakis (National Observatory of Athens, Institute for Astronomy, Astrophysics, Space Applications & Remote Sensing, Greece)



The most recent observational campaigns have placed the total number of galaxies in the Universe in the trillions. The majority, if not all of them, are thought to host at their centers large black holes, millions or even a billion times heavier than our Sun. These beasts build up their mass over time by devouring material from their surroundings. During this process they emit huge amounts of energy that impacts the physical conditions of the surrounding interstellar and intergalactic medium, with far-reaching implications for the formation and evolution of



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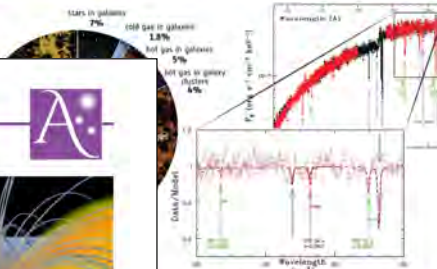
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N-body simulation of the cosmic web as traced by galaxies and active galactic nuclei. The orange dots (MultiDark programme) show the positions of simulated galaxies. These are organised in groups, and clusters, which in turn are connected by filaments and separated by low-density voids. The cyan dots mark active supermassive black holes within the galaxy population. The Athena X-ray Observatory will map the distribution of accretion events (i.e. the red stars) on the cosmic web and explore the connection between activation of the supermassive black-hole and the density of the local environment.
Credit: Antonis Georgakakis

The hunt for missing baryons has opened

Jelle Kaaman and Fabrizio Nicastro (ISRON (Netherlands Institute for Space Research) & Leiden Observatory, The Netherlands (INAF-Osservatorio Astronomico di Roma, Italy & Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA)

Modern cosmology tells us that the bulk of our Universe consists of mysterious dark energy and dark matter. Only a tiny fraction (about 5%) of the total is normal matter (called baryons). In the distant Universe we have detected this normal matter via its absorption of



553+112: XMM-Newton/RGS1 (black) and RGS2 (red) (black and red lines) for the blazar IES 1553+112. Grey lines: green and magenta arrows indicate absorption in system detected. Credit: Picot et al., *MNRAS*, 399, 2018.

absorption lines and far enough to enhance all possible lamps, and found the ideal source X-Newton and got 1.85 Ms (3 solid weeks!) of

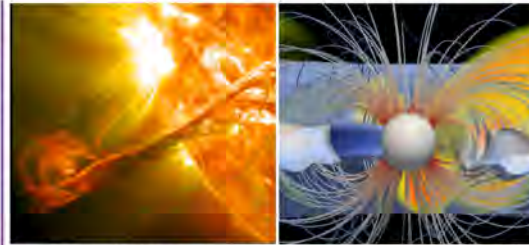
were found, at wavelengths in agreement with ing baryons.

s a small number. Quite some uncertainty re-spect, about their physical properties, and U on board *Athena*. Its spectral resolution is more than a hundred such systems by obser-gant!

The Fast and the Furious: extreme stellar flares

S. Sciortino and I. 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.



Left: On August 31, 2012 as a result of a flare a CME erupted out into space with a speed of over 1800 km/s and connected with Earth's magnetosphere, causing auroras. Credit: NASA. Right: 3D MHD (Magnetohydrodynamic) simulation of flaring activity occurring close in 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. Orlandi

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 to trace the motions and changes of abundances due to matter evaporating from the stellar chromosphere and/or 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.

NOVEMBER 2019



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OCTOBER 2019

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DECEMBER 2019

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Athena is supported by a hard-working world-wide community of active astronomers. Their human faces are shown via short biographical extracts in the Athena web pages. Maybe yours will be next!

Athena Community People



Luigi Piro

Luigi Piro is director of research at IAPS, INAF of the Athena Science Study Team (ASST) and ...


After his graduation at University of Roma, in Bologna, as research staff, working on EXOSAT the development of BeppoSAX instrumentation in Japan as visiting scientist in RIKEN, co-leading per on the disk reflection features in Active Gal with GINGA. Back in Rome, as ASI project scientist he directed the scientific activities of the mission those on Gamma-Ray Bursts (GRBs), for which he Rosati and the Descartes Prize.

He currently leads the development of Transconductors (TES) for X-ray Astrophysics and the tium in Italy and he is the coordinator of the INF infrastructure project for High Energy Astroph main science topics are GRB as probes of the universe and its large scale structures.



Credit: ESA, Illustration by Maria Eusewiler, ESA/ECF

Athena Community People



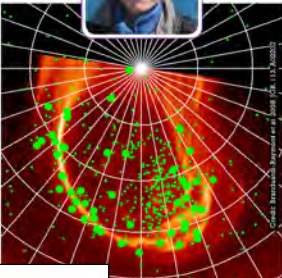
Graziella Branduardi-Raymonte

Graziella is Professor of Space Astronomy at the Mullard Science Laboratory of University College London (UCL). She has a Physics degree from the University of Milano, and a PhD in Astronomy from UCL; she also worked at the Harvard-Smith Center for Astrophysics, for a couple of years.

She has participated in major X-ray observatory missions: pernicus, Ariel 5 and the Einstein Observatory in the 70s, EXOSAT in the 80s, ROSAT in the 90s. She is Co-I for the XMM-Newton and co-leader of the Solar wind Magnetosphere Ionosphere Explorer mission (SMILE), jointly developed by ESA and the Chinese Academy of Sciences. Her scientific interests encompass the full range of astronomical X-ray sources, from AGN to solar system objects (and our own Earth). The latter are reflected in the activities she carries out in support of Athena.


Graziella is a member of the Athena X-IFU Science Advisory Group and co-chair of the Topical Panel on 'Solar system objects and planets'.

Graziella has been fascinated by astronomy and space ever since she was a teenager and considers herself very fortunate to have been able to make a career out of her scientific passion.



Credit: ESA, Illustration by Maria Eusewiler, ESA/ECF

Athena Community People




Jörn Wilms

Jörn did his PhD (1998) and habilitation (2002) in Ruediger Staubert's X-ray astronomy group in Tuebingen (D). From 2004 until 2006 he was a lecturer in astronomy and astrophysics at the University of Warwick. Since 2006, he has been a professor for astronomy and astrophysics at the University of Erlangen-Nuremberg.

Jörn is mainly interested in Athena observations of X-ray binaries and Active Galaxies (relativistic lines, reflection, SED studies), but also in spectroscopic studies of photoionized plasmas and the ISM in general. As a member of the eROSITA consortium, he is also looking forward to following up observations of eROSITA discovered sources.

Within the Athena team, Jörn is responsible for the group of people developing the end to end simulation software for the WFI and the X-IFU detectors.



Credit: ESA, Illustration by Maria Eusewiler, ESA/ECF

Athena Community People



Natalie Webb

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

Natalie's research is focused on the origin and the growth of supermassive black holes seeds, and on constraining the properties 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 infrastructure, vide 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!



Credit: Heidi Segard

Illustration view of the innermost accretion disk of a black hole (M_• = 10⁶ M_☉, z = 0.1) in ESO 241-9

Athena Community People



Hironori Matsumoto

Hironori is a high-energy astro-physicist at Osaka University, Japan. He started his career by studying X-ray emissions from early-type galaxies and clusters of galaxies using the ASCA satellite. Then he discovered the X-ray source M82 X-1 with Chandra and started to study ultra-luminous X-ray sources. Now Hironori is interested in X-ray emissions from the central region of the Milky Way Galaxy, especially the follow-up X-ray observations of unidentified TeV gamma-ray sources, so-called "dark accelerators". Besides these X-ray observations, he has been heavily involved in the development of X-ray instruments. Hironori participated in the development of the X-ray CCD (X-ray Imaging Spectrometer) on board the Suzaku satellite, and then he developed the Hard X-ray Telescope (HXT) on board the Hitomi satellite as a deputy leader of the HXT team.

Hironori is chair of the ISAS Athena working group, and a member of the Athena Science Study Team on behalf of ISAS/JAXA. He is co-chair of the SWCS, Observatory science of Athena.



Credit: JAXA

Athena Community People



Laura Brenneman

Laura is an astrophysicist at the Smithsonian Astrophysical Observatory (Cambridge, MA, USA). She studies the X-ray properties of supermassive black hole systems in AGN and has leadership roles in designing future X-ray missions for NASA, and other international space agencies. Laura has been a pioneer in the field of determining how fast black holes spin and has published over 40 articles in scholarly journals on her research, including a short book on measuring the angular momenta of black holes (Springer, 2013).

Laura is currently a co-leader of Athena's "Energetic Universe" science working group, charged with overseeing the development of the science objectives and observing plan for the study of the formation, growth and evolution of moderate- to high-redshift AGN, feedback from local AGN and star-forming galaxies, the immediate environments of supermassive black holes, the physics of accretion in stellar-mass binary systems, and luminous extragalactic transients.



Credit: NASA/JPL-Caltech/R. Hurt (SDSS)

DECEMBER 2019



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NOVEMBER 2019

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Framework Programme of the European Union

ATHENA

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📘 The Athena X-ray Observatory

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