May 2024

The High Energy Astrophysics Division Newsletter

Editors: Renee M. Ludlam (Wayne State University), Drew M. Miles (The California Institute of Technology), Michael F. Corcoran (NASA/GSFC & The Catholic University of America)

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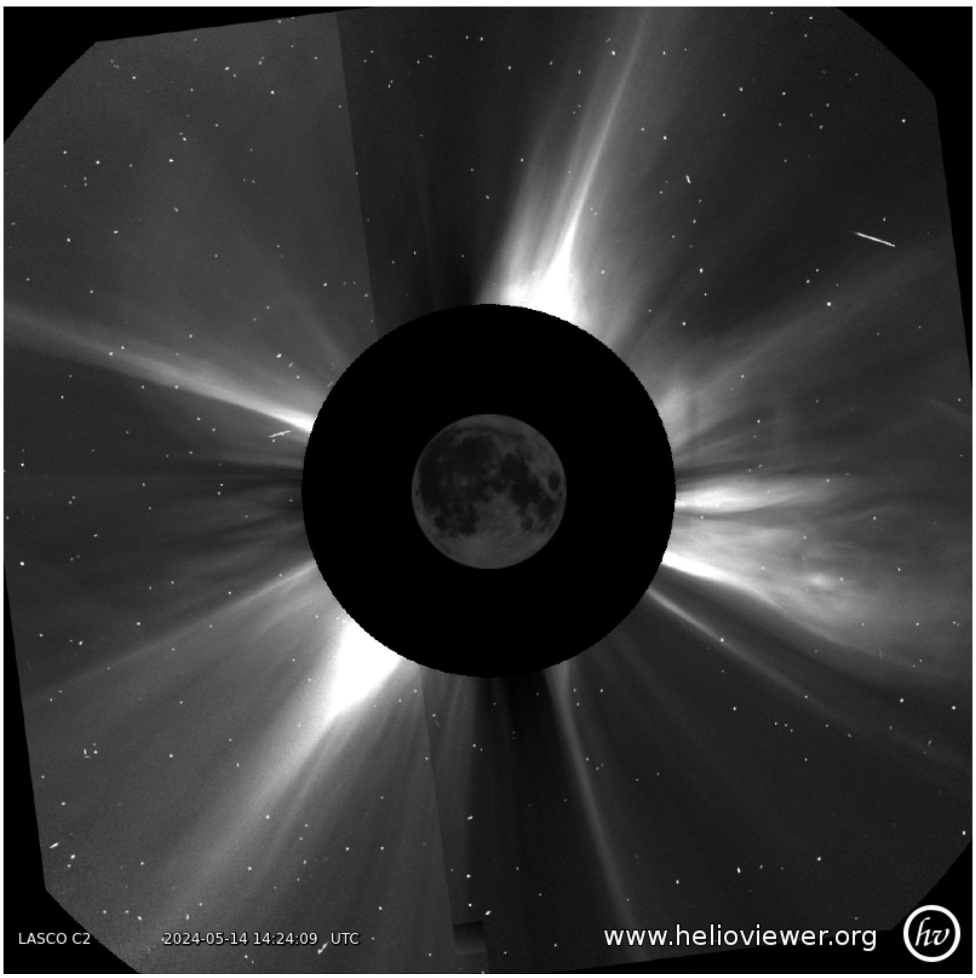


An eclipse-like image captured by the LASCO instrument on the SOHO spacecraft on April 8, 2024. The image includes a picture of the Moon for scale. Credit: SOHO

The View from the Chair

Kristin Madsen (NASA GSFC)

In writing my first column as the HEAD chair, I had hoped for happier times for our community, but these last months of insecurity about the budget and subsequent cuts have put us under a dark cloud. Chandra has gone into a (mini) senior review, along with Hubble, to decide the funding and operational priorities of these two missions going forward. The outcome is far from certain, and we may sooner than anticipated face a period without a major X-ray observatory. Striving for optimism, the X-ray probes are currently being evaluated with a down-select anticipated at the end of the year. An X-ray probe launched in the mid 30's will go a long way towards securing the near-future of high-energy astrophysics in the US. But, again, an X-ray probe might not happen. Fortunately, ESA's Athena mission has emerged from its redefinition phase and is moving forward again. The success of Athena hinges upon contributions from NASA, and it is of vital importance that the US science community reengages with Athena to signal the optimism necessary to guide the budgetary priorities of NASA in the future years to secure the Athena commitment.

In much brighter news, HEAD convened at the 21st divisional meeting at Horseshoe Bay, Texas in conjunction with the solar eclipse. Inclement weather had everyone fretting, but eventually, the clouds parted, and the sun was able to show off nature's greatest spectacle to an awed crowd of HEAD members and family. The meeting began Sunday with an amazing public talk by David Pooley, which concluded with a stunning rendition of "Total Eclipse of the Sun" performed by Amy Pooley and David Dubose. Due to the eclipse, the official science program started on Tuesday, but Monday afternoon featured a special plenary by Mark Clampin addressing the financial challenges of the astrophysics program. Throughout the week, we had a slew of exciting contributed talks and all of six prize talks. All the talks have been made available on the meeting webpage. A special thanks goes to our new deputy secretaries Drew Miles and Renee Ludlam who helped make this meeting a success.

The next HEAD meeting will be held in St. Louis, and the decision to host there is in direct response to the request by HEAD members for more affordable meetings. The HEAD EC believes this location achieves this by being centrally located, not only in the country but also in a city offering easy access to dining and an array of affordable accommodations. Prior to picking this venue, the EC, together with the AAS conference team, investigated the possibility of a university campus-based meeting. Over the last year, we contacted numerous sites, but for the size of the HEAD meetings, along with several logistical considerations, such as the location of facilities, restricted availability due to football seasons, and accessibility to accommodations, we concluded that at this time it is not feasible to host a HEAD meeting on a university campus.

Finally, I would like to express my heartfelt gratitude towards the out-going EC members Thomas Maccarone and Terri Brandt, and Past Chair Fiona Harrison for their excellent service. Their contributions have been invaluable. I also want to extend a warm welcome to our newest EC members Paul Plucinsky and Carolyn Kierans, and new Vice Chair Colleen Wilson-Hodge. Welcome!

News from the HEAD

Megan Watzke, the HEAD Press Officer (CfA)

There has been a true mixed bag of press coverage for HEAD missions in the past six months. Of course, HEAD missions continue to produce spectacular and fascinating results that are shared with the public through press releases and other means. However, the budget narrative, largely surrounding Chandra, has taken quite a bit of the spotlight this spring. Since March, there have been articles in the Washington Post, USA Today, Popular Science, Space News, and many more describing the ongoing discussion around Chandra's future.

The challenging budget news is balanced by exciting developments across the HEAD portfolio, including the launch of the Einstein Probe, new results from XRISM, eROSITA, and many more. Also look for ongoing activities throughout this year to celebrate the quarter century of operations by both Chandra and XMM-Newton!

Some of the recent science highlights include:

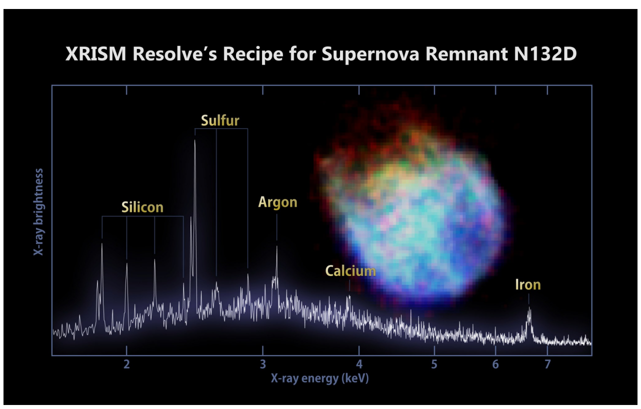
- May 8, 2024: "NASA, JAXA XRISM Spots Iron Fingerprints in Nearby Active Galaxy"
- April 30, 2024: "Cosmic Dance of the 'Space Clover'"
- April 30, 2024: "NASA/JAXA's XRISM Mission Captures Unmatched Data with Just 36 Pixels"
- April 27, 2024: "Einstein Probe First Light"
- April 16, 2024: "NASA's Fermi Mission Sees No Gamma Rays from Nearby Supernova"
- March 26, 2024: "Marvel at Stunning Echo of 800-year-old Explosion"
- February 21, 2024: "Black Hole Fashions Stellar Beads on a String"
- February 14, 2024: "NASA Telescopes Find New Clues About Mysterious Deep Space Signals"
- January 11, 2024: "NASA's Fermi Detects Surprise Gamma-ray Feature Beyond Our Galaxy"
- January 11, 2024: "NASA Scientists Discover a Novel Galactic 'Fossil'"
- January 8, 2024: "NASA Telescopes Chase Down 'Green Monster' in Star's Debris"
- December 9, 2023: "NASA's IXPE Marks Two Years of Groundbreaking X-ray Astronomy"

As always, we encourage shameless self-promotion. If you've got a recent science result that may be of interest to the public at large, please contact the HEAD press officer, Megan Watzke. And if you've got an interesting image based on (or involving) high-energy observations, objects or processes, contact Mike Corcoran for consideration as a High Energy Astrophysics Picture of the Week.

XRISM

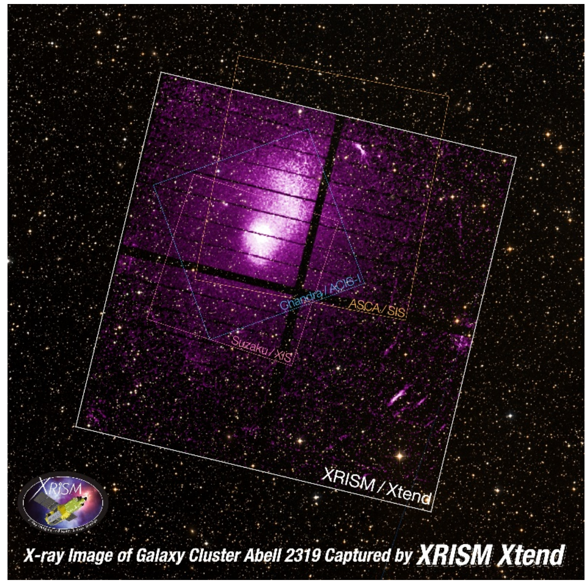
Brian J. Williams, Richard L. Kelley (NASA GSFC)

The X-ray Imaging Spectroscopy Mission (XRISM), an international JAXA/NASA collaboration including participation from ESA, is an advanced X-ray observatory capable of carrying out a science program that will address some of the most important questions in astrophysics. XRISM was launched on September 6th, 2023 and officially began science observations on February 8th, 2024. XRISM is now in its six-month Performance Verification (PV) phase, during which the performance of the instruments will be confirmed through observations of a wide variety of celestial targets, including (but not limited to): X-ray binaries, active galactic nuclei, clusters of galaxies, and supernova remnants. The list of targets, along with a brief description of the observations and the immediate science goals, can be found on the XRISM PV target webpage. The PV phase is expected to end in August 2024, and all PV phase observations will be available to the public one year after the end of the PV phase.



XRISM's Resolve instrument captured data from supernova remnant N132D in the Large Magellanic Cloud to create the most detailed X-ray spectrum of the object ever made. The spectrum reveals peaks associated with silicon, sulfur, argon, calcium, and iron. Inset at right is an image of N132D captured by XRISM's Xtend instrument. Credit: JAXA/NASA/XRISM Resolve and Xtend

On January 5th, 2024, the XRISM project released the first light spectra and images. The Resolve soft X-ray spectrometer has an energy resolution of ~ 4.5 eV across the energy range of $\sim 0.3 – 12$ keV, separating previously indistinguishable lines in the supernova remnant N132D, an approximately 2,500 year old remnant in the LMC. The Xtend soft X-ray imager provides a $38' \times 38'$ Field of View (FoV). Xtend's first light image is a wide-field view of the Abell 2319 cluster of galaxies. Xtend's unique capability to capture the entire cluster in a single observation reveals the intricate distribution of hot cluster gas, promising a significant advancement in our understanding of galaxy clusters and the evolution of the large-scale structure of the Universe.



Galaxy cluster Abell 2319 is a system where two clusters of galaxies collide about 770 million light-years away in the northern constellation Cygnus. The image is a superposition of optical and Xtend X-ray observations from October 14 to October 24, 2023. The X-ray image is shown in purple. Credit: X-ray: JAXA; Optical: The Digitized Sky Survey

Resolve is performing exceptionally and already conducting exciting science despite an issue with the aperture door covering its detector. The door, designed to protect the detector before launch, has not opened as planned after several attempts. The door blocks lower-energy X-rays, severely reducing sensitivity at $E < 1.7$ keV. The XRISM team will continue to explore the anomaly and is investigating different approaches to opening the door. The Xtend instrument is unaffected.

After the PV phase of the mission is concluded, the mission will enter the General Observer (GO) phase. During the GO phase yearly calls for observing proposals will be issued simultaneously by NASA (for scientists in the US and Canada), ESA (for scientists located in ESA member states) and JAXA (for scientists located in Japan and the rest of the world). Responses to the Cycle 1 solicitation were due April 4th, 2024. Over 300 proposals were received worldwide, with a time oversubscription request of $\sim 5{:}1$. The results of the Cycle 1 review will be announced later this summer. Funding will be available through NASA for successful proposers based at US institutions.

The second XRISM Community Workshop was held at the University of Maryland from January 17 – 19, 2024. The primary objective of this workshop was to prepare the astronomical community for the Cycle 1 GO Call for Proposals. This workshop consisted of talks and hands-on sessions with experts from the XRISM team and covered XRISM analysis techniques and software relevant for Cycle 1 proposals, with the goal of maximizing the use of Resolve's unique high resolution spectrometry, and wide-field imaging provided by Xtend. Over 50 participants attended this workshop in-person with ~ 100 more online. All presentations are available via video and slide deck from the workshop website. The XRISM Guest Observer Facility will continue to hold these community workshops on a regular basis.

The Einstein Probe

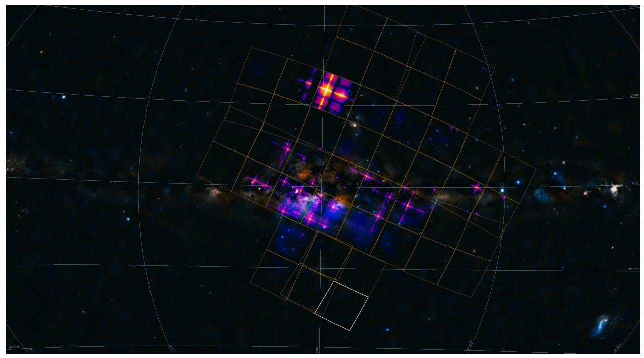
Hui Sun, Congying Bao and Weimin Yuan (NAO,CAS)

The Einstein Probe (EP), a mission dedicated to time-domain high-energy astrophysics, was successfully launched from the Xichang Satellite Launch Center in China on January 9, 2024. EP is a mission led by the Chinese Academy of Sciences (CAS), in collaboration with the European Space Agency (ESA), the Max Planck Institute for extraterrestrial Physics (MPE), Germany and Centre National D'Etudes Spatiales (CNES), the French space agency. One of the two payloads of EP is a Wide-field X-ray Telescope (WXT), which employs novel lobster-eye micro-pore optics (MPO) to enable focused X-ray imaging with a large instantaneous field of view of 3,600 square degrees, a moderate spatial resolution ($5'$ FWHM) and good sensitivity (2 – 3pm $\times 10^{-11}$ erg cm^{-2}s^{-1} in the 0.5–4 keV band in a 1 ks exposure).

The launch of Einstein Probe on January 9, 2024 from the Xichang Satellite Launch Center in China. Credit: Zhang Jing/Xinhua

With the unprecedented capability of WXT and the fast response of EP's Follow-up X-ray Telescope (FXT), EP is expected to characterize cosmic high-energy transients and flares over a wide range of time-scales at high cadences. EP will reveal new insights into dormant black holes, neutron stars, supernova shock breakouts, active galactic nuclei, X-ray binaries, gamma-ray bursts, stellar coronal activity, gravitational-wave events and other extreme cosmic phenomena. EP will also monitor the variability of relatively bright known X-ray sources all over the sky.

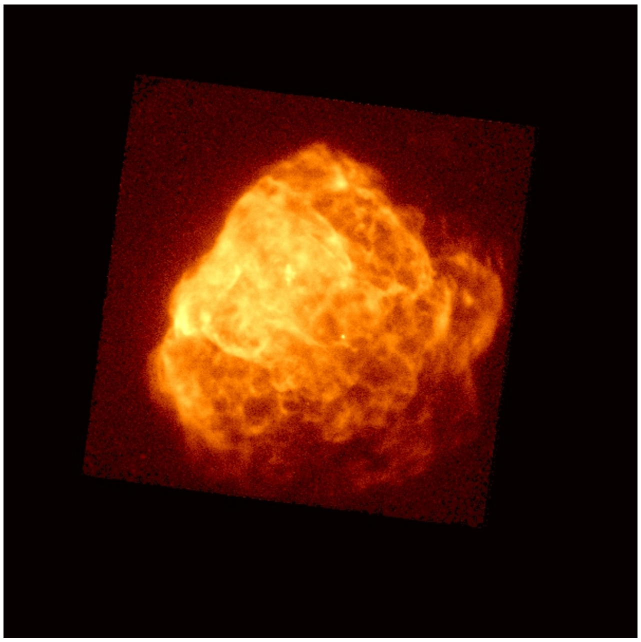
Since the launch of the EP satellite on January 9, a series of commissioning tests have been conducted, which have confirmed the functionality and performance of the spacecraft and its payloads. During the commissioning phase, EP has captured X-ray images from supernova remnants, globular clusters, X-ray binaries, cluster of galaxies, and to distant quasars. These observations have demonstrated the outstanding capabilities of EP's two scientific instruments.



A 40 ksec EP-WXT image directed at the center of the Milky Way Credit: Einstein Probe Science Center

The WXT calibration observations have been completed for all the 12 modules. The calibration results show that WXT meets the EP's scientific requirements, with a positioning accuracy of about $2'$, an angular resolution of $4'$ to $5'$ and a light collecting area of approximately 3 cm^2 at 1 keV. The results also verified its unique large field of view, good sensitivity and fast time-domain surveying and monitoring capabilities. Calibration of FXT also verified its effective area (300 cm^2 at 1.25 keV, for the two identical units), spatial resolution ($23''$ at 1 keV) and source positioning capabilities. FXT also has window and timing modes, which reduce pile-up effects for (relatively) bright sources. Rapid uplink of FXT commands needed for time-critical follow-up observations has also been verified. FXT has performed timely follow-up observations of several transients initially detected by WXT, pinpointing the source to better than $10''$ accuracy. In the upcoming months, EP will continue to carry out its in-orbit calibration, before entering the formal operational phase, starting sometime in June, 2024.

The EP consortium (CAS, ESA, MPE and CNES) released the first set of EP images, taken with both WXT and FXT, at the end of April. During the commissioning phase EP has detected more than a dozen X-ray transients. These transients include gamma-ray bursts, magnetic cataclysmic variables and possibly a new type of X-ray sources. These detections were reported in over 20 global GCN/ATel messages. These findings have guided a range of ground- and space-based telescopes to carry out follow-up observations in multi-wavebands, including Keck, VLT, GTC and SALT in the optical; VLA, ATCA and MeerCAT in radio; and X-ray followup by Swift/XRT, NICER and Chandra. Preliminary analysis of the X-ray data from EP and multi-wavelength data from other telescopes confirmed EP's potential to detect distant or faint transients and variable objects of interesting astrophysical origins.



With a FoV of 1°x1°, EP-FXT provides an unrestricted and clear view of the overall shell structure of Puppis A, a nearby supernova remnant with strong X-ray emission, located at a distance of approximately 1.3 kpc and approximately 4000 years old. Credit: Einstein Probe Science Center

LIGO-Virgo-KAGRA Collaboration

J. McIver (The University of British Columbia) & P. R. Brady (UW-Milwaukee)

The first part of the latest LIGO-Virgo-KAGRA (LVK) observing run, O4a, ended on 16 January 2024 when the LIGO detectors began a planned commissioning break. The two LIGO detectors (LIGO Hanford and LIGO Livingston) and the Virgo detector began the second part of the run, O4b, on 10 April 2024. O4b is currently expected to continue until February 2025. The LVK is reviewing the timetable for the work between O4 and O5.

The two LIGO detectors are currently operating with a sensitivity of 155-175 Mpc and the Virgo detector with a sensitivity of 55-60 Mpc. We expect there will be further minor adjustments to optimize the performance of all three detectors during O4b. Thus far in O4b, the detector network has had over 40% triple coincidence observing time (with all three detectors observing) and nearly 80% uptime with two or more detectors observing.

On the first of January 2024, the KAGRA detector experienced a 7.6 magnitude earthquake close to the site; the largest nearby earthquake in the past century. Although the vacuum system remains intact, KAGRA suffered damage to multiple mirror suspensions. The KAGRA team will finish recovery work before restarting commissioning and joining O4b before the end of the observing run with a target BNS range of $\sim$ 10 Mpc.

In O4a (24 May 2023 through 16 January 2024), the LIGO-Virgo-KAGRA collaboration identified 81 significant gravitational-wave candidate events with low-latency searches, plus 11 retracted candidates and 1610 low significance candidates.

As of mid-May (since 10 April 2024), the LIGO-Virgo-KAGRA collaboration has identified more than 12 significant gravitational-wave candidate events with low-latency searches in O4b, plus 3 retracted candidates. We note that an elevated rate of retracted candidate events at the beginning of a run with a new detector configuration is normal as the online searches burn in their background estimates. In addition, more than 200 low-significance alerts have been released thus far in O4b.

As offline analyses are completed with improved understanding of detector performance and noise background, the list of O4 candidates is expected to change and their estimated source properties may also shift.

The LVK recently announced the discovery of compact binary merger GW230529 with an estimated primary (heavier) component mass between 2.5 and 4.5 solar masses. This candidate is particularly interesting as electromagnetic observations of galactic neutron-star and black-hole masses suggest a paucity of objects in the mass range of this object, which has led to a discussion of a possible mass-gap between neutron stars and black holes. GW230529 and future gravitational-wave detections will help us study this gap region in more detail and address outstanding questions about compact object formation and binary evolution.

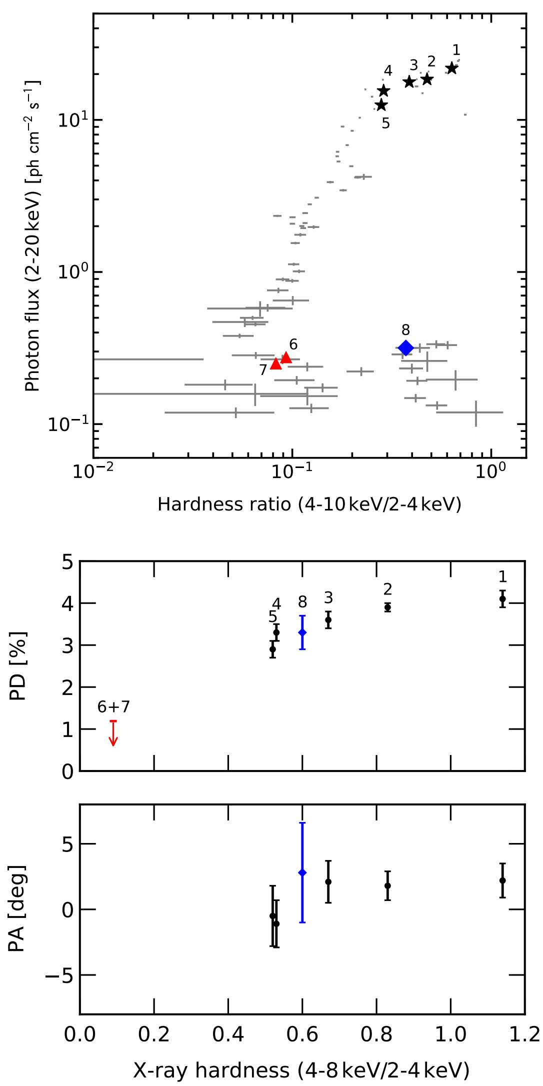
Although there are not yet any unretracted binary neutron star event candidates during O4, the collaboration has deployed early-warning gravitational wave searches for binary neutron star mergers capable of issuing alerts ahead of merger times.

More information about public alerts, including instructions for subscribing to alert notifications, can be found in the LIGO-Virgo-KAGRA public alerts user guide. If you would like to keep track of the status of the observatories during the observing run, you can visit the Gravitational Wave Open Science Center's detector status page.

Imaging X-ray Polarimetry Explorer

Philip Kaaret & Steve O'Dell (NASA/MSFC)

Martin Weisskopf, Paolo Soffitta, and the Imaging X-ray Polarimetry Explorer (IXPE) team were awarded the 2024 HEAD Bruno Rossi Prize "for their development of the Imaging X-ray Polarimetry Explorer whose novel measurements advance our understanding of particle acceleration and emission from astrophysical shocks, black holes, and neutron stars." We congratulate Martin and Paolo for their leadership of IXPE and applaud their persistence in pursuing an X-ray polarimetry mission. We will host an event in Huntsville on September 18 to celebrate the Rossi prize. USRA will host the International X-ray POlarimetry Symposium (IXPO) in Huntsville on September 16-19, 2024. Visit the meeting web site for details and to submit abstracts due May 28, 2024.



Top - Hardness-intensity diagram for Swift J1727.8−1613. IXPE observations are numbered in chronological order. Bottom - Polarization degree (PD) and angle (PA) versus hardness. Credit: Podgorný et al., 2024

IXPE completed its prime mission on February 3, 2024. During its 754-day baseline Science mission (starting January 11, 2022), IXPE conducted 115 observations of 64 distinct sources, for a total exposure of 38 Ms. There have been 69 refereed papers published reporting new IXPE results. The HEASARC IXPE publications page reports 153 IXPE science-related refereed papers. Thus, IXPE is producing a strong science return.

IXPE is now in the General Observer (GO) phase. We greatly appreciate the efforts of those of you who served on the GO review; your efforts are essential to maximizing IXPE's scientific output. A total of 103 Ms of IXPE time was requested for an oversubscription factor higher than 6 (the review panels had to make some tough calls). There were over 1400 co-I's representing 174 institutions from 30 countries. There were 99 distinct targets proposed, including source classes not considered for the prime mission. The approved proposals included 7 theory, 1 large, and 31 regular proposals (13 category A, 10 category C, and 8 ToO). ToO's were very highly oversubscribed, by a factor of 9. The large number of targets and high oversubscription suggest that IXPE will continue to produce scientifically compelling results for many future cycles.

The IXPE GO cycle-2 deadline is August 29, 2024, earlier than the cycle 1 deadline. We encourage everyone to start writing their proposals now. There are several changes for this cycle. ToO proposals with unspecified target coordinates will be allowed. We are continuing the joint program with NICER and adding joint programs with NuSTAR and with Swift. We are not requesting Notices of Intent. Also, Swift GO cycle 21, with proposals due on September 26, 2024 will award IXPE time (200 ks and one medium priority ToO).

To help people in preparing proposals, there will be a joint NICER/IXPE Workshop July 29 – August 1 to be held in-person in Washington, DC, and virtually. We will provide updates on the missions' status and GO programs. The last day will be a hands-on session with NICER and IXPE experts guiding participants through the data analysis. Registration is free with a deadline for in-person attendance of July 1 and for remote attendance of July 26.

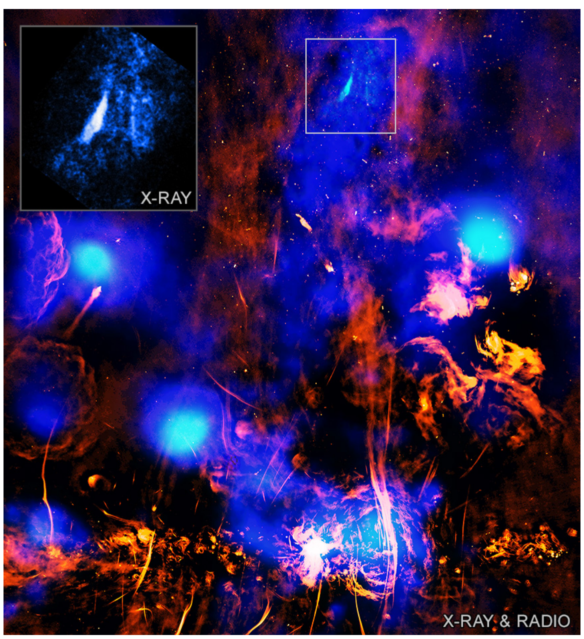
The IXPE Users Committee (IUC) will now serve as the primary means for the IXPE user community to communicate with the IXPE Project and NASA Headquarters (HQ). The inaugural committee membership is Eileen Meyer (UMBC, chair), Tiziana Di Salvo (Università degli Studi di Palermo), Unatti Kashyap (Texas Tech University), Alan Marscher (Boston University), Fabio Muleri (IAPS/INAF), Michael Nowak (Washington University), and Roger Romani (Stanford). The first IUC meeting was held on May 10; the second will be during IXPO. Please use the contact form or e-mail the Chair at meyer@umbc.edu to provide feedback about the mission, the GO program, analysis tools, workshops, etc.

IXPE has now followed a black-hole X-ray transient, Swift J1727.8-1613, across a full outburst, having caught the initial hard state, the soft state, and the dim hard state following the soft-to-hard transition near the end of the outburst. The observations spanned the prime mission and GO phase (Prop. #1220, PI Svoboda). The hard state X-ray polarization angle (PA) aligns with the sub-mm PA, suggesting that the corona is extended in the disk plane, rather than along the jet axis (Veledina, A., et al. 2023, ApJ, 958, L16). During the initial hard state, the PA remains constant while the polarization degree (PD) is correlated with hardness and power spectral hue (Ingram, A., et al., 2024, arXiv:2311.05497, ApJ, in preparation). QPOs were detected in the hard state, but no modulation of PD nor PA with QPO phase was detected (Zhao, Q.-C. et al., 2024, ApJ, 961, L42). The PD drops dramatically in the soft state (Svoboda, J., et al., 2024, arXiv:2403.04689, ApJL submitted). Remarkably, the PD in the dim hard state, at a luminosity two orders of magnitude lower, follows the same trend (Podgorný, J., et al., 2024, arXiv:2404.19601, A&A submitted). Explaining the polarization evolution with standard models requires fine tuning of the parameters and may point to key challenges for our understanding of accretion flow in X-ray binaries. Further IXPE observations of other black hole transients across full outburst cycles, possible with an extended mission, are needed to determine whether these are general trends.

The Chandra X-ray Observatory

EDWARD MATTISON & MARK WEBER (SAO); STEVEN EHLERT & STEVE O'DELL (NASA/MSFC)

Now in its 25th year, the Chandra X-ray Observatory (CXO) continues its highly successful science mission. With unique sub-arcsecond X-ray imaging, Chandra provides key information for many astrophysically significant X-ray and multi-wavelength investigations.

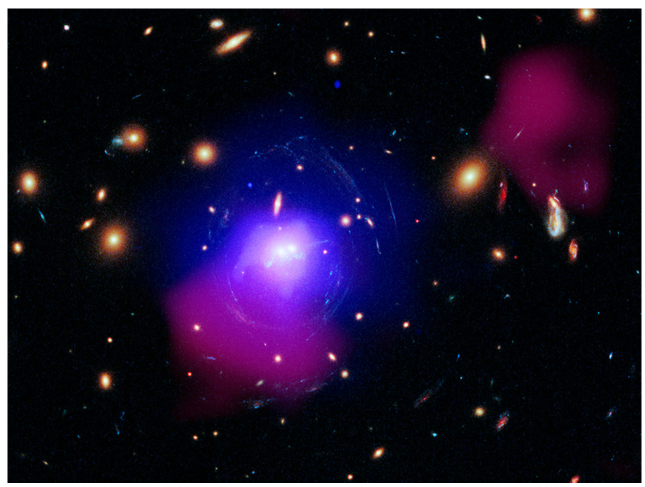


Region near the Milky Way's Galactic Center, showing the (blue) X-ray emitting "chimney" from the Galactic Center, with a ridge feature (inset) that might serve to vent shocked hot gas. Credit: X-ray (blue): NASA/CXC/UChicago/S.C. Mackey et al.; Radio (red/orange): NRF/SARAO/MeerKAT; Image Processing: NASA/CXC/SAO/N. Wolk.

Chandra observing time remains highly sought after. Last June's dual-anonymous peer review of the 408 General Observer (GO) proposals submitted for Cycle 25, approved 103 observing proposals and 21 archive and theory proposals. In March of this year, the CXC received 406 Cycle-26 GO proposals, including 58 archive and 23 theory proposals. The 325 Cycle-26 observing proposals requested a total of 65.5 Ms, roughly 5.5 times the time available for GO observations. The Cycle-26 GO proposals, plus proposals for the new Chandra Legacy Program, will be evaluated this summer.

Chandra remains an ideal observatory for understanding the physics and impacts of AGN across a large range of length scales. Starting with our nearest supermassive black hole, Sgr A*, Chandra observations have provided new independent measurements of its spin and identified linear ridge features perpendicular to the Galactic Plane that may be associated with past outflows from the Milky Way's central engine.

On larger scales, Chandra has recently observed two extreme examples of AGN feedback at the centers of galaxy clusters. At one extreme, the quasar at the center of the cluster H1821+643 does not appear to be suppressing the runaway cooling flow usually suppressed by AGN feedback. At the other extreme, the galaxy cluster SDSS J1531+3414 was shown to have some of the most powerful AGN jets yet observed in a galaxy cluster. This particular system also shows 19 stellar "superclusters" spanning the region between the two central galaxies of this cluster.



Multiwavelength image of galaxy cluster SDSS J1531+3414, showing two colliding galaxies spawning 19 large star clusters (cyan beads immediately below the pair of interacting galaxies). Credit: X-ray (blue): NASA/CXC/SAO/O. Omoruyi et al.; Optical (amber/cyan): NASA/ESA/STScI/G. Tremblay et al.; Radio (red): ASTRON/LOFAR; Image Processing: NASA/CXC/SAO/N. Wolk.

The Chandra Observatory continues to function at or near pre-launch expectations. Incremental changes in performance of some components continue, generally in line with pre-launch predictions, without hindering operations. The performance of the spacecraft's thermal insulation continues to decline gradually; however, this trend has been mitigated by careful mission scheduling, aided by increasingly sophisticated software tools. The gradual accumulation of molecular contamination onto the ACIS optical blocking filter reduces ACIS's sensitivity to low-energy (below about 1.5 keV) X-rays. Chandra maintains its mission-long observing efficiency of about 70%, collecting data on science targets during about 90% of the potentially available observing time. (To protect its instruments, Chandra cannot observe during passages through Earth's radiation belts. Further, spacecraft maneuvers, instrument setup, and other procedures also necessarily use some of the time.)

NASA has instructed the Chandra X-ray Observatory program, as well as the Hubble Space Telescope program, to take part in an Operating Paradigm Change Review aimed at evaluating potential science return that could be achieved with substantially reduced budgets, using revised mission operations models. The Chandra program submitted its information package in April and presented its operational options to the review panel in May. More information about this review may be found at the Chandra X-ray Center website.

The Chandra Project looks forward to celebrating Chandra's 25th anniversary at numerous events during the year, including a science symposium in Boston this December. Here's to many more years of scientific discovery with Chandra!

XMM-Newton

Lynne Valencic (JHU/NASA) & Kim Weaver (NASA)

Successful submissions from the Twenty-third Call for Proposals for XMM-Newton were announced in December 2023, and observations will begin in May. U.S. PIs with A or B ranked targets were invited to submit a budget proposal; results will be announced in August.

The Twenty-fourth Call for Proposals will open August 20, and the final date to submit proposals will be October 11, 12:00 UT (8:00 a.m. EDT). The final approved program will be announced in mid-December.

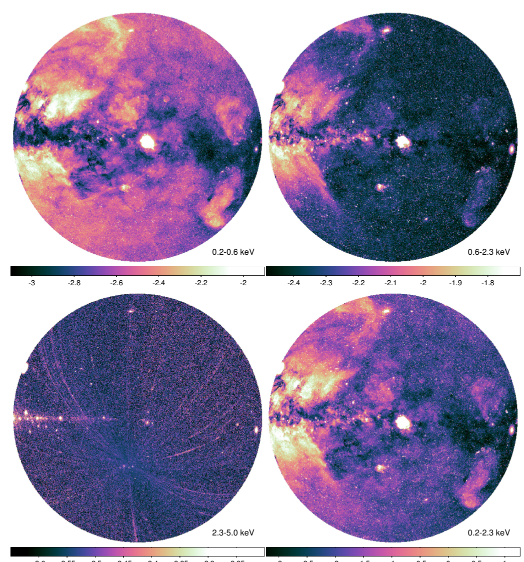
The SOC is holding a science workshop at ESAC at Villafranca del Castillo in Madrid, Spain on the topic of "The X-ray Mysteries of Neutron Stars and White Dwarfs". A host of topics will be covered, including magnetars, isolated neutron stars, ULXs, recycled and transitional pulsars, and accretion onto compact objects. Registration is free, but the deadline is May 29. Please note that this will be live streamed! The proceedings will be published in a special edition of *Astronomical Notes*. More information, including on the live stream, can be found on the workshop website.

Please note that the presentations from last summer's symposium on "The X-ray Universe" are now available from the symposium website.

SRG/eROSITA/ART-XC

A. Merloni (MPE), A. Lutovinov (IKI), P. Predehl (MPE), S. Sazonov (IKI)

The first eROSITA-DE data release, or DR1, went online on January 31, 2024. The German eROSITA consortium released all X-ray data collected in the Western Galactic hemisphere (20,626.5 square degrees) during the first scan of the eROSITA all-sky survey (eRASS1), over a six-months period from December 2019 to June 2020. DR1 data contains calibrated event lists in the 0.2 – 10 keV energy band, images, exposure maps, background maps, and sensitivity maps as well as flux upper limits in different energy bands. These data products are organised in separate sky fields of 3.6×3.6 degrees. In addition, source spectra and light curves for (bright) targets that exceed detection likelihood of 20 in the 0.2 – 2.3 keV band are also released. A custom-made tool called eRODat offers an interactive way of visualizing the DR1 data and catalogues, and a "shopping cart" can be used to select and download data of interest. Released data can be displayed using HiPS maps. The standard `eSASS` software package needed to analyse the eROSITA data is also included in the release.



Four examples of half-sky maps released as part of eROSITA-DE DR1, displaying the X-ray sky as observed in the 0.2 – 0.6 keV (top left), 0.6 – 2.3 keV (top right), 2.3 – 5 keV (bottom left) and 0.2 – 2.3 keV (bottom right) bands. The maps are color-coded by the logarithm of the count rate intensity (in cts s^{-1} $arcmin^{-2}$), displayed in Zenith Equal Area (ZEA) projection in Galactic coordinates, with pixel size of 0.09 deg^2 and centered on $(l, b) = (270°, 0°)$. Credit: Merloni et al. (2024).

As part of DR1, several source catalogs were released:

- A *Main* catalog of (point-like and extended) X-ray sources detected in the most sensitive 0.2 – 2.3 keV band above a detection likelihood of 6 (approximately 930,000 sources);

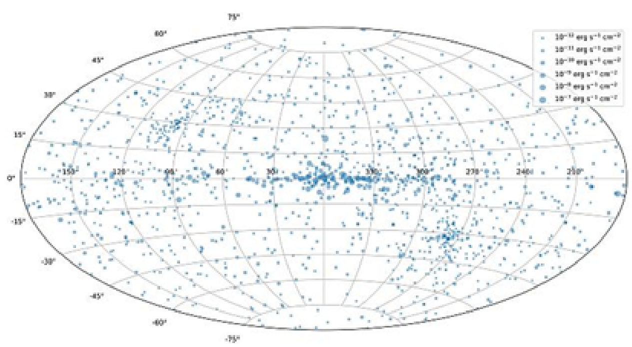
- A *Supplementary* catalog of (point-like and extended) X-ray sources detected in the most sensitive 0.2 – 2.3 keV band with detection likelihood between 5 and 6 (approximately 347,000 sources);
- A *Hard* catalog of (point-like and extended) X-ray sources detected in the less sensitive 2.3 – 5 keV band above a detection likelihood of 12 (5,466 sources);
- A primary catalog of 12,247 optically confirmed galaxy *groups and clusters* detected in the 0.2 – 2.3 keV as extended X-ray sources in a 13,116 square degree region in the western Galactic hemisphere, spanning the redshift range $0.003 < z < 1.32$;
- A *Cosmology* highly pure cluster catalog of 5,259 optically confirmed galaxy groups and clusters detected in the 0.2 – 2.3 keV as extended X-ray sources in a 12,791 square degree region in the western Galactic hemisphere, spanning the photometric redshift range $0.1 < z < 0.8$. This catalog is used in the eRASS1 cosmology analysis presented in Ghirardini et al. (2024);
- A catalog of likely coronally emitting X-ray stars identifications of the eRASS1 Main sources using Gaia and the HamStar Bayesian association method (Freund et al. 2024).

Coordinated with the release, the German eROSITA Consortium has submitted almost 50 new scientific publications to peer-reviewed journals, with selected discoveries including a giant filament of pristine warm-hot gas extending between two galaxies, two new 'Quasi-Periodically Erupting' black holes (QPE), further studies of how X-ray irradiation from a star may affect the atmosphere and water retention of orbiting planets, statistical analysis of flickering supermassive black holes, and many more.

Following DR1, on February 14, 2024, the first Cosmology results from the analysis of the clusters counts distributions were also released, marking the coming of age of clusters of galaxies as a competitive cosmological probe. The eROSITA cluster observations show that matter of all kinds (visible and dark) comprises 29% of the total energy density of the Universe at present, and measure the S8 "clumpiness" factor (related to the normalization of the power spectrum of fluctuations) of S8 = 0.86, in very good agreement with the values obtained from Planck measurements of the cosmic microwave background radiation, at similar precision.

After the end of eRASS1, and before being placed into safe mode in February 2022, eROSITA had completed three more full scans (and a partial one) of the entire sky. These data are currently being analysed, and will also be released to the public in the coming years, with DR2 and DR3 currently planned for 2026 and 2028.

From December 12, 2019 to March 7, 2022, the Mikhail Pavlinsky telescope aboard the SRG observatory made four full scans of the sky in hard X-rays and additionally covered nearly 40 per cent of the sky for a fifth time. Based on the entirety of data collected during this period, scientists at the Space Research Institute in Moscow together with their colleagues from other institutes and universities in Russia and the USA have produced a new map of the sky in the 4 – 12 keV energy band. They detected 1545 individual sources on this map, and the resulting catalog, called ARTSS1-5 (for "ART-XC sky surveys 1 – 5"), has just been published in Astronomy and Astrophysics. Most of the sources in the new catalog were known from previous X-ray missions, but nearly 10 per cent are newly discovered. The majority of ARTSS1-5 sources have already been classified, at least tentatively, based on cross-correlation with external catalogs and dedicated follow-up optical spectroscopic observations. Nearly two thirds are active galactic nuclei and the rest are mostly Galactic sources of various types. On October 19, 2023 SRG/ART-XC resumed its all-sky survey, completing a new scan every six months (the most recent one was finished on April 24, 2024). The all-sky survey will presumably continue until the end of 2025, which will allow the ART-XC team to produce a final catalog of sources.



Positions in Galactic coordinates of the X-ray sources detected by ART-XC during the all-sky survey. The size of the symbol reflects the X-ray brightness of a source.

NICER

KEITH GENDREAU & ZAVEN ARZOUMANIAN (NASA/GSFC)

The Neutron Star Interior Composition ExploreR (NICER) continues to operate productively despite damage sustained by its X-ray Timing Instrument (XTI) in May 2023 due to orbital debris: some of the thin optical-blocking filters that cover the 56 X-ray concentrator optics were punctured, allowing daylight into the instrument's interior. This "light leak" and the resulting optical loading of the silicon drift detectors during orbit day causes internal telemetry saturation, substantially degrading data quality. During orbit night, all detectors operate nominally and data quality remains excellent. In addition to prioritizing scheduling during orbit night, the NICER team has introduced some daytime-only operational changes to mitigate the effects of the light leak, but the impact to overall capabilities remains significant. Much of the data collected in sunlit conditions exhibits unusual behaviors; NICER users are urged to exercise caution in interpreting any unexpected spectral or timing features, which may be spurious and unrelated to any astrophysical phenomenon. Additional information and best practices for analyzing data in the presence of the light leak are available on NICER's Analysis Tips and Caveats page.

The NICER patch kit. Twelve triangular patches are shown installed within two flight-spare NICER sunshades, mounted in a rectangular aluminum caddy. This kit will fly to the International Space Station in August 2024, where crewmembers will carry it outside to install five of the patches at specified locations on NICER's X-ray Timing Instrument, covering holes created in May 2023 by orbital debris and restoring dark conditions within the XTI. The hexagonal hole at the center of each patch is designed to accommodate a tool already available to astronauts onboard ISS. Credit: K. Gendreau

International Space Station (ISS) leadership, following extensive discussions and technical reviews, has approved a plan to "repair" NICER—i.e., to patch the damaged thin films and restore dark conditions within the XTI, with minimal (<2%) impact to X-ray collecting area. Approaches involving both ISS robotics and astronaut spacewalks (extravehicular activity, or EVA) were evaluated, and the decision was made to proceed with an EVA repair. A dedicated patch kit has been developed and delivered for launch on an ISS resupply flight scheduled for August 2024. Astronauts are currently training for the repair, which is expected to take place in November 2024, at NASA Johnson Space Center's Neutral Buoyancy Laboratory, where a large swimming pool containing models of ISS structures and payloads enables simulation of weightlessness for astronauts on spacewalks.

Cycle 6 of NICER's General Observer (GO) program is underway; observations for targets approved in the NuSTAR Cycle 10 and National Radio Astronomy Observatory 24B opportunities through our joint programs will begin soon. NICER time is also available through similar joint GO programs with the Swift, TESS, and IXPE missions.

NICER's scheduling agility enables coordination with many facilities on the ground and in space, as well as observations of a large number of ToOs, which may be proposed by any observer at any time through the NICER Target of Opportunity/Discretionary Time Request form. NICER's visibility windows for a given target are complicated by occultation from structures (such as the large solar arrays) on the ISS; an Enhanced Visibility Calculator provides accurate start-stop visible times for any specified target coordinates within a 14-day horizon. Additional capabilities to improve responsiveness to transients include the automated grid searches of localization uncertainty regions for new sources, such as those detected by JAXA's Monitor of All-sky X-ray Image (MAXI), which is also an ISS payload. In partnership with JAXA, the NICER team operates the Orbiting High-energy Monitor Alert Network (OHMAN), a software payload running on an ISS laptop that implements automated triggering between MAXI and NICER. OHMAN enables NICER to respond to MAXI-detected transients on timescales, in the best cases, of just a few minutes (see science highlight below). NICER's near-term observing schedule is always available on the NICER website at the HEASARC.

NICER data analysis software (NICERDAS) is distributed through the HEASoft package. The latest release, 6.33, offers several new capabilities as part of NICERDAS 12, including features that specifically address calibration and filtering related to the optical light leak. New end-to-end analysis tools are also available—with substantial new documentation in the form of analysis threads—to generate spectra, lightcurves, and background estimates based on the sophisticated SCORPEON model. Feedback on NICERDAS performance is welcome through the HEASARC helpdesk system.

The HEAD community is invited to register and participate in a Summer 2024 data-analysis and science workshop, jointly organized with IXPE. The in-person component of the hybrid meeting, July 29-August 1, will take place at George Washington University in Washington, D.C., with the final day consisting of hands-on data-analysis training with on-site experts. Registration is free, and details may be found at the workshop website.

The NICER Users Group (NUG) continues to provide the mission with expert guidance on data-analysis capabilities, calibration, and other user support functions. The NUG meets, independently of NICER mission leadership, in the spring and fall of each year. The community is encouraged to communicate with the NUG; contact information, the NUG Charter, and meeting details are provided at the NICER User Group website. Expressions of interest to serve on the NUG are also welcome.

Recent NICER science results include:

- The discovery (Hu et al. 2024) of a pair of spin glitches in magnetar SGR 1935+2154, closely bracketing a bright radio burst similar in properties to the mysterious extragalactic fast radio bursts (FRBs). Rapid spin-down between the glitches suggests the release of a dense magnetospheric wind that may have set up the conditions for the radio burst.
- Evidence for Lense-Thirring precession of a newly-formed accretion disk following a stellar tidal-disruption event (TDE). Pasham et al. (2024) find X-ray flaring unaccompanied by visible or UV modulations, with a recurrence time of 15 days and lasting approximately 120 days after an optical transient resembling a typical TDE. The spectral evolution of the X-ray flares suggests relativistic precession of an accretion disk gradually aligning with the spin axis of a supermassive black hole with spin parameter less than ~ 0.5.
- Continuing study of the quasi-periodic eruption (QPE) phenomenon on ever-longer timescales. Chakraborty et al. (2024) track the source known as "eRO-QPE1" across 3.5 years of observations to assess the viability of the leading model for the origin of hour-timescale soft-X-ray flashes from the nuclei of nearby galaxies: extreme mass-ratio inspirals (EMRIs) involving a supermassive black hole and a stellar-mass compact companion, an anticipated source-class for gravitational-wave studies with LISA.
- Prompt follow-up of a long-duration Type I X-ray burst from the neutron-star low-mass X-ray binary 4U 1850−087. An April 24, 2024, trigger from MAXI through OHMAN resulted in a NICER observation beginning just 3 minutes after the MAXI detection. Deep modulations in flux during the burst's decaying tail, seen previously on just two occasions, were captured with NICER's full effective area, enabling time-resolved spectroscopy. A preliminary analysis reveals candidate absorption and emission lines; a full analysis is in progress.

Additional NICER science highlights are posted each week as NICER Science Nuggets on the NICER website.

Neil Gehrels Swift Observatory

S. Bradley Cenko (NASA/GSFC)

The Neil Gehrels Swift Observatory continues to operate exceptionally well as it approaches its 19 year launch anniversary (November 20, 2023). The mission supports five Target-of-Opportunity (ToO) requests per day from the community, in addition to observing gamma-ray bursts (GRBs) and Guest Investigator (GI) targets. Swift is by far the most active mission in terms of number of ToOs accepted and variety of sources observed.

On Friday, March 15 the Swift satellite entered safe mode due to the failure of an on-board gyroscope. The spacecraft was designed to accommodate the failure of one gyroscope and still meet all mission requirements. However, the on-board flight software required a patch to allow the satellite to operate properly in two-gyroscope mode. The team reacted quickly and returned the satellite to full science observations on April 3. Thanks to the flight software update, the spacecraft attitude control is currently better than at any previous point in the mission lifetime!

Cycle 20 GI observations began executing shortly after the spacecraft resumed science operations in early April. 58 programs were awarded observing time as part of Cycle 20, on sources ranging from nearby comets to distant blazars and gamma-ray bursts.

Using a new capability developed by the X-Ray Telescope (XRT) team, scientists recently discovered a black hole in a distant galaxy nibbling on a Sun-like star. When a star strays too close to a monster black hole, gravitational forces create intense tides that break the star apart into a stream of gas. The leading edge swings around the black hole, and the trailing edge escapes the system. These destructive episodes are called tidal disruption events. Astronomers see them as flares of multiwavelength light created when the debris collides with a disk of material already orbiting the black hole. Recently, astronomers have been investigating variations on this phenomena, which they call partial or repeating tidal disruptions. During these events, every time an orbiting star passes close to a black hole, the star bulges outward and sheds material, but survives. The process repeats until the star loses too much gas and finally breaks apart. The characteristics of the individual star and black hole system determine what kind of emission scientists observe, creating a wide array of behaviors to categorize. This new partial TDE discovery was recently reported in Evans et al. in Nature Astronomy (2023, 7, 1368-1375).

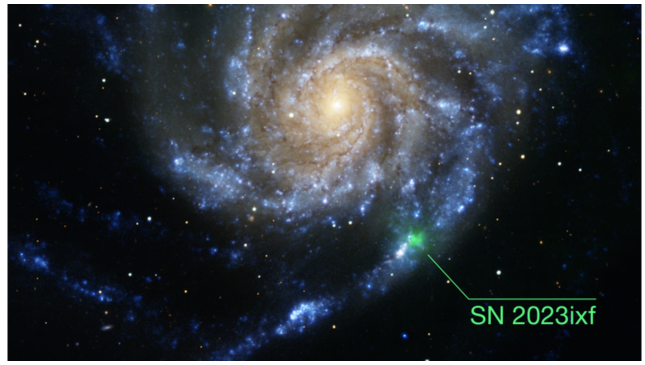
The Livings Swift-XRT Point Source (LSXPS) catalog provides low-latency searches for new transient X-ray events fainter than those available to the current generation of wide-field imagers, and reports their detection in near real time. The LSXPS catalogue covers 5,526 square degrees on the sky and contains position, fluxes, spectral details and variability information for 315,679 X-ray point sources detected in observations with the Swift X-ray Telescope between January 2005 and May 2024. Each source has a detection flag which indicates how likely it is to be a real astrophysical object. Table 1 shows summary information for the catalogue, and is automatically updated. Fig. 1 shows the latest details of the sky coverage. More information about the Living Swift XRT Point Source catalog can be found at the LSXPS website.

NuSTAR

Daniel Stern (JPL), Karl Forster (Caltech), & Brian Grefenstette (Caltech)

The selection of NuSTAR Cycle 10 targets was released on April 22, which entailed a slight increase in both the number of submitted proposals and the number of selected proposals. Overall, the cycle had a healthy oversubscription of more than 3:1, similar to the last several cycles. Despite increasing the amount of ToO time available relative to Cycle 9 (which was also an increase relative to Cycle 8), ToO observations remained the most highly overscribed category of proposals, again with an oversubscription of more than 6:1. Accepted ToO targets include gravitational wave counterparts, interacting supernovae, tidal disruption events, Galactic X-ray binaries, blazars, changing look AGN, novae, and Solar activity. Many programs requesting NuSTAR coordination with approved XRISM Cycle 1 and IXPE Cycle 2 programs were also approved. In the future, the NuSTAR project plans to provide the opportunity for formal coordinated observations between these satellites, as the project currently does with Chandra, Swift, XMM-Newton, NICER, and INTEGRAL. Overall, NuSTAR is executing approximately 100 proposals per year, with $>50\%$ of observations coordinated with other observatories and $>75\%$ having time constraints.

On the science front, the NuSTAR project recently posted a press release detailing observations of the nearby core-collapse supernova SN 2023ixf in M101 (AKA the Pinwheel Galaxy). The alert that this "Supernova of the Decade" had been found arrived at the NuSTAR Science Operations Center late on a Friday afternoon, just hours after the supernova had been discovered. Thanks to the hard work of the NuSTAR operations team, the telescope was able to observe M101 starting early Monday morning, roughly four days after the supernova was discovered. For comparison, it was 17 days before NuSTAR observed the supernova of the previous decade, SN 2017eaw in NGC 6946 (AKA the Fireworks Galaxy). Swift had already started observing M101 but had not detected any X-ray emission. In the high-energy X-rays observed by NuSTAR, the supernova already shone brightly. X-rays are caused by a shock wave plowing into material lost by the star in the years before it died. As that circumstellar material spreads out over time, it becomes less dense and less absorbing of low-energy X-rays. In the observation taken 4 days after the explosion, absorption from this gas and dust was clearly seen in the NuSTAR data. However, when NuSTAR returned to look at the supernova again roughly a week later, the absorption was gone (and the soft X-ray signal began to appear).



Only four days after the explosion, NuSTAR observed the nearby core-collapse supernova SN 2023ixf in M101. NuSTAR data (green) shows the X-ray detection of the supernova. The X-ray data are overlaid on an archival optical image (NOIRLab/KPNO, yellows and reds) that has been combined with a far-UV image from GALEX (blue). Image credit: NASA/JPL-Caltech/NOIRLab/NSF/AURA/B. Grefenstette (Caltech); Image processing: R. Hurt (Caltech-IPAC)

Grefenstette et al. (2023; ApJL, 952, L3) find that four days after the explosion, the shock had traveled 38 AU, roughly equivalent to the distance from the Sun to Pluto. At that distance, the supernova ejecta was encountering material lost by the progenitor star only three and a half years before it exploded. Eleven days after the explosion, the shock had traveled out to 96 AU and was catching up with stellar wind released a decade before the star exploded. In this way, NuSTAR provides a unique view into the explosion physics and the last years of a massive star's life. Excitingly, another "Supernova of the Decade" was detected earlier this year, SN 2024ggi in NGC 3621, at a distance similar to SN 2023ixf. NuSTAR was able to begin observing this event even faster, only 2.1 days after discovery, and again found a heavily absorbed event at early times.

On a separate front, and inspired by the realization that NuSTAR shields detected GRB 221009A, the so-called "Brightest of All Time" or the "BOAT", the NuSTAR project has announced a new capability as a gamma-ray burst detector. The NuSTAR Search for INteresting Gamma-ray Signals (SINGS) project searches data from the NuSTAR CsI anti-coincidence shields and X-ray detectors for gamma-ray bursts. While NuSTAR is widely known as the first focusing hard X-ray observatory, the CsI anti-coincidence shields provide a large effective area to sources far from the optical axis of the observatory (e.g., through the side of the telescope). A post-facto search for GRBs detected by other observatories in the 2020-2022 time range resulted in the detection of several "famous"

GRBs such as GRB 221009A and GRB 230307A. This led to the development of a real time detection pipeline that searches the telemetry stream for signs of GRBs and identifies roughly one GRB per month.

Finally, we encourage users to subscribe to the NuSTAR users list by sending an email with 'subscribe' in the subject to nustargo-join@lists.nasa.gov. In particular, if you change institutions, please sign up again with your new address.

Insight-HXMT

SHIJIE ZHENG & SHUANG-NAN ZHANG (IHEP, CAS)

The *Insight*-Hard X-ray Modulation Telescope (*Insight*-HXMT) continued observations of black holes, neutron stars in 1-250 keV and GRBs in 80-2000 keV. Data out of proprietary period can be downloaded freely from the *Insight*-HXMT official website. The *Insight*-HXMT Data Analysis Software (HXMTDAS) and the CALDB have been regularly updated and the latest versions are V2.06 and V2.07, respectively. More information about the progress, user support and results of *Insight*-HXMT can be found at the Insight-HXMT website (in English and Chinese).

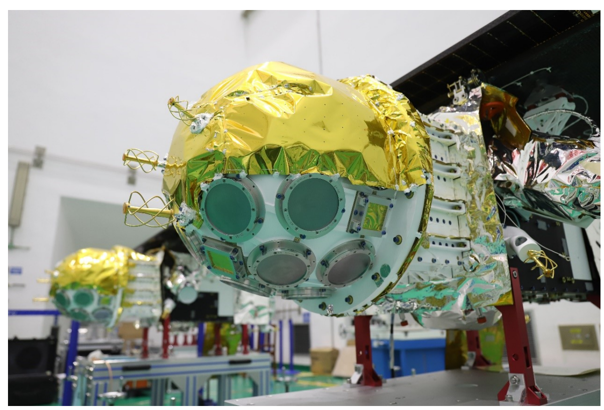
Many important new results have been published recently based on *Insight*-HXMT observations. First of all, the Hilbert-Huang Transform Method has been employed successfully on analysis of timing data, resulting in the recovery of the high-energy low-frequency quasi-periodic oscillations (QPOs) from MAXI J1535-571 (Shui et al, ApJL, 2024). Additional significant discoveries include detection of a thick accretion disk inflated by the high luminosity of 4U 1543–47 during its 2021 outburst (Zhao et al, A&A, 2024), characterization of broad-band noise and quasi-periodic oscillations of the X-ray pulsar RX J0440.9+4431 (Li et al, MNRAS, 2024), detection of pulsed iron line emission from the first galactic ultraluminous X-Ray pulsar, Swift J0243.6+6124 (Xiao et al, ApJ, 2024),study of the cyclotron line evolution using pulse-to-pulse analysis during the outburst of 1A 0535+262 (Shui et al, MNRAS, 2024), early detection of the afterglow of GRB 221009A in X-Ray and Gamma-Ray energy bands (Zheng et al, ApJ, 2024), and establishing the QED magnetic reconnection origin of an FRB-associated X-ray burst (Xie et al, Science Bulletin, 2023). *Insight*-HXMT, along with observations with NICER and NuSTAR, provided important new insights into the newly discovered black hole X-ray binary Swift J1727.8-1613 (Peng et al, ApJL, 2024). All of these data have been made publicly available and we encourage additional in-depth investigations. Please visit *Insight*-HXMT's publication list for more details.

Insight-HXMT's sixth observing cycle will conclude August 31, 2024. The cycle-7 guest observer program is now open to the whole international scientific community, and the deadline for cycle-7 proposals is June 15, 2024. Please see the *Insight*-HXMT AO-07 white book for more information on the program. As of March 31, 2024, a total of 24 non-ToO observations, 17 ToO observations, and the Galactic plane scan of ~1.0 ms have been performed in AO-6. In addition, many joint observations have been carried out with INTEGRAL, IXPE, NICER, EP, LEIA, FAST, KM40m, etc. See the long-term and short-term plans, and list of observed sources for more information.

GECAM

CHEN-WEI WANG, SHAO-LIN XIONG, SHI-JIE ZHENG (IHEP, CAS)

GECAM (Gravitational wave high-energy Electromagnetic Counterpart All-sky Monitor) is a satellite constellation to monitor all-sky X-ray and γ-ray transients in the multi-messenger and multi-wavelength era. GECAM is currently composed of four instruments (GECAM-A, B, C and D). The main science topics include Gamma-Ray Burst (GRB), especially those associated with Gravitational Wave events (GW-GRB), high energy counterparts of Fast Radio Bursts (FRBs), Soft Gamma-ray Repeaters (SGRs), X-ray bursts from X-ray Binaries (XRBs), Solar Flares (SFLs), and Terrestrial Gamma-ray Flashes (TGFs) and Terrestrial Electron Beams (TEBs).



Flight model of the GECAM satellite. Credit: IHEP/CAS

GECAM observations have produced new and interesting results. GECAM measured the record-breaking isotropic energy of the unprecedented GRB 221009A accurately, demonstrating that it was indeed the BOAT, the "brightest burst of all time" (An et al., 2023). With joint observation of GECAM-C, *Insight*-HXMT and *Fermi*/GBM, a comprehensive measurement of the early afterglow of the "BOAT" GRB revealed interesting features of the afterglow: an unusual V-shape spectrum, achromatic jet break and energy-dependent flux decay slopes (Zheng et al., 2024). Furthermore, emission lines up to about 37 MeV were discovered, and the power-law evolution of the line energy and flux were revealed for the first time in GRB 221009A via a joint analysis of GECAM-C and

Fermi/GBM. This suggests that the emission line is blue-shifted 511 keV emission from electron-positron annihilation in the relativistic jet (Zhang et al., 2024).

GECAM-B triggered the GRB 230307A in-flight and promptly downlinked the trigger alerts to the ground using the BeiDou navigation system. GECAM-B discovered that this was an extremely bright GRB, resulting in a global observation campaign of this burst. Thanks to high dyanmic range of GECAM, both GECAM-B and GECAM-C accurately measured this extremely bright GRB without any saturation issues. Joint analysis of GECAM and LEIA data provided evidence for the emergence of a magnetar (Sun et al., 2023).

GECAM data can be downloaded from the GECAM archive. We also provide GECAM data analysis software (GECAMTools) and a GECAM calibration database CALDB. More information about GECAM can be found at the GECAM website.

The Fermi Gamma-ray Space Telescope

ELIZABETH HAYS, CHRIS SHRADER, JUDY RACUSIN, DAVE THOMPSON (GSFC), LYNN COMINSKY (SONOMA STATE U.)

The *Fermi* scientific instruments, Gamma-ray Burst Monitor (GBM) and Large Area Telescope (LAT), continue to monitor the entire gamma-ray sky. Operations have remained largely routine. For only the second time since the mission started, *Fermi*'s propulsion system was recently used to avoid a potential collision with another orbiting object.

In 2023, Fermi celebrated its fifteenth launch anniversary. Science highlights from the first 15 years of Fermi operations have now been published as an e-book, "Our High Energy Universe: 15 Years with the Fermi Gamma-ray Space Telescope". Data from the LAT have been used to construct a time-lapse movie of the gamma-ray sky. In honor of International Women's Day, the project released social media featuring some of the women from institutions around the world who work with Fermi.

The Fermi instruments alert the community about possible electromagnetic counterparts and good candidate gamma-ray bursts that match gravitational wave events from the LIGO/Virgo/KAGRA O4 run. The GBM team puts out regular GCN notices and circulars, while the LAT team has set up a page to report automatic follow-ups to gravitational wave alerts. These announcements will soon use the new General Coordinates Network.

At the 243rd meeting of the American Astronomical Society in New Orleans, an unexpected and unexplained feature in the *Fermi*-LAT data was reported. This is surprisingly consistent in amplitude and is approximately aligned with the dipole peak seen by the Pierre Auger Observatory in ultra high-energy cosmic rays. Another unexpected *Fermi* result presented at this meeting was the discovery that solar gamma rays were preferentially seen from the polar regions during solar maximum, near the time the solar magnetic field flipped.

Supernova SN 2023ixf in the nearby Pinwheel galaxy offered an opportunity to test predictions that young supernovae are strong cosmic-ray accelerators. Fermi-LAT observations found no gamma-ray emission, putting strong constraints on supernova cosmic-ray acceleration models.

The 2024 *Fermi* Summer school will be held from May 28 to June 7. The Eleventh International Fermi Symposium will be held September 9-13 in College Park, Maryland.

Current Fermi software and documentation are available through the Fermi Science Support Center. The current version of the Fermitools is available on GitHub. For instructions on how to install the tools, release notes, troubleshooting, error reporting, and other related documentation see the Fermitools Wiki. The latest release of the GBM Data Tools is also available on GitHub as a package in the Gamma-ray Data Tools.

The Cycle 17 Guest Investigator program saw a nearly 30% increase in proposal submissions compared to the Cycle 14-16 average. These proposals are currently in review. Please find details about the Guest Investigator program at the Fermi Science Support Center website. The Cycle 17 proposal selections will be announced this summer.

There are now six "stained glass" gamma-ray art posters available through the *Fermi* project. If you are missing a few or would like a set, please send email to Lynn Cominsky.

If you have job/research/degree opportunities relevant to the gamma-ray community, the LAT Collaboration has an Opportunity Board where those can be posted.

Finally, we are pleased to welcome Andrea Prestwich to the Fermi mission team as the new lead scientist for the Science Support Center. Chris Shrader recently stepped down from this role after many years of much appreciated service. Please join us in honoring the outstanding impact Chris has had on high energy astrophysics through his scientific leadership of the Fermi Science Support Center and Guest Investigator Program.

INTEGRAL

JAN-UWE NESS (ESA-ESAC), STEVEN STURNER (UMBC & NASA/GSFC)

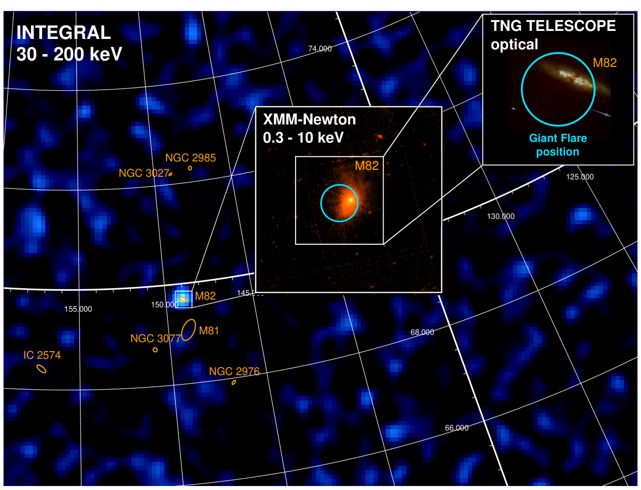
The INTEGRAL mission (launched in 2002) constitutes the far (high-energy) end of ESA's panchromatic astronomy fleet ranging from infrared (e.g., Planck, JWST) to gamma-rays (INTEGRAL). Mission and Science Operations are running nominally following the now well-established procedures for angular momentum control via observation attitudes (rather than thrusters).

Following a decision of the Science Programme Committee (SPC), INTEGRAL is scheduled to reduce science operations on January 1, 2025, which involves stopping all observations (science, calibration etc.) and focusing on the generation of the INTEGRAL Science Legacy Archive (ISLA). Meanwhile, mission operations will continue at a lower level with monitoring and, when necessary, controlling the spacecraft until re-entry early 2029.

In May 2024, the last SPI annealing, #42, is scheduled to be performed. Scientific observations were executed following the 2024 long-term plan and included coordinated observations with other ground- and space-based facilities, and several Targets of Opportunity.

Registration and abstract submission are open for the INTEGRAL Workshop 22 Years of INTEGRAL: Catching Results and Discoveries, to be held at ESAC, Madrid from 21 to 25 October 2024. This is the latest in the series of ESA-sponsored conferences to highlight the science of the mission, to discuss novelties in high-energy astrophysics, the new era of time-domain and multi-messenger astronomy, new instrumental facilities, and innovative data-analysis methods, with a focus on maximizing INTEGRAL data exploitation now and in the decades to come.

The next meeting of the INTEGRAL User Group (IUG) is scheduled for May 27/28 at ESOC, Darmstadt, Germany. Items planned to be discussed include the future role and members of the IUG during the post-operations phase and the legacy archive.



On November 15, 2023, INTEGRAL detected a burst of gamma-rays lasting only a tenth of a second, and determined it came from the nearby star-forming galaxy M82. The small square on INTEGRAL's map above shows the location of the burst. The blue circle on the two inset images shows the corresponding location of the burst. Credit: ESA/Integral, ESA/XMM-Newton, INAF/TNG, M. Rigoselli (INAF)

As its name implies, INTEGRAL observations have been integral to many important science results over the past year. Two nature papers have recently appeared on neutron stars. A simultaneous INTEGRAL+radio observing campaign has studied the influence of thermonuclear bursts in accreting neutron stars on the jet outflows whose launching mechanism is poorly understood. Important new insights were gained and published by Russell et al., 2024, Nature 627, 763. This study showed that, while material is flowing in via accretion from a companion star, there is also a continuous, collimated outflow launched at extremely high speeds (a jet). The accreted H-rich material that has gathered on the neutron star's surface undergoes frequent thermonuclear bursts which affects the accretion inflow, increasing the rate at which material falls onto the star. The INTEGRAL+radio observations revealed that the bursts also feed the jets with additional material that could be traced as it flowed down the jet, providing a precise estimate of the speed of the jets from a neutron star for the very first time. This work was featured in an ESA Press Release.

On November 15, 2023, INTEGRAL coincidentally detected a 0.1-second gamma-ray flare in M82 while observing the neighboring galaxy M81 as part of a TAC approved guest observer programme. During this short flare the amount of energy released was comparable to the energy emitted by the Sun in 100,000 years. Crucially, INTEGRAL provided an accurate localization which pinpointed the host galaxy and thus constrained the distance and the absolute energy budget of the flare. These observations showed that the flare occurred in a starburst galaxy with a population of relatively young neutron stars. The combined data strongly suggests that this burst occurred on a magnetar. An ESA press release was published on April 24, 2024, based on the *Nature* article, "A magnetar giant flare in the nearby starburst galaxy M82".

On 22 April 2024, the "super-event S240422ed" triggered immediate reaction from INTEGRAL, which reported an upper brightness limit (GCN 36247), The INTEGRAL upper limit was consistent with the upper limit obtained by Fermi (GCN 36241).

All refereed publications making use of INTEGRAL data can be found in the INTEGRAL refereed paper library on ADS. INTEGRAL Science highlights are routinely reported as Pictures Of the Month (POM). See the POM Archive for a list of astounding science results.

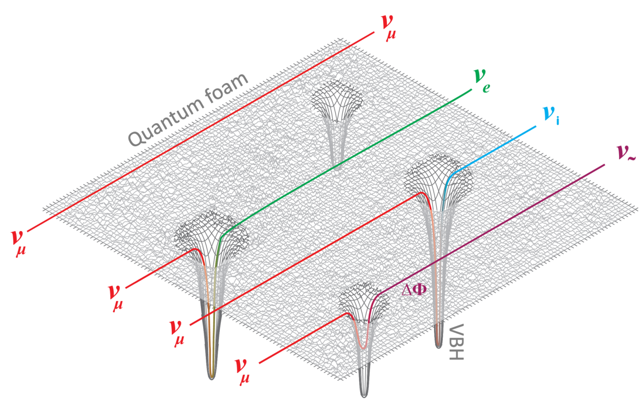
IceCube Alisa King-Klemperer (UW-Madison)

The unification of quantum theory and gravitation remains one of the most outstanding challenges in fundamental physics today. One mystery is the quantum nature of spacetime—a fusion of the three dimensions of space and the fourth dimension of time—and whether it is subject to the randomness seen in other quantum theories, resulting in fluctuations at very small distances and times.

The oscillation between flavor states—electron, muon, and tau—of tiny, nearly massless particles called neutrinos is a quantum process, where any perturbations induced by quantum gravity would distort the neutrino flavor composition. Because neutrinos only interact through the weak force and gravity, they are largely isolated as they propagate through space. This isolation allows quantum coherence to be measured over macroscopic distances, acting as natural interferometers for probing the structure of spacetime.

A large high-energy sample of neutrinos detected by the IceCube Neutrino Observatory, a cubic-kilometer array embedded in the Antarctic ice shelf, was used to put stringent constraints on spacetime fluctuations due to quantum gravity. In a paper published in March in *Nature Physics*, the IceCube Collaboration presented a study of neutrino decoherence as a result of small fluctuations in spacetime caused by quantum gravity. Specifically, the researchers looked at atmospheric neutrinos in the energy range of 0.5 – 10 TeV, using simulated and real data, and at distortions of observed energy- and direction-dependent neutrino flavor compositions due to spacetime fluctuations. No evidence of neutrino decoherence was observed, placing the strongest constraints on neutrino-quantum gravity interactions, significantly improving previous limits in a range of scenarios.

"Our results are over a million times stronger than the previous ones in well-motivated parts of the parameter space," says Benjamin Jones, an associate professor at the University of Texas at Arlington (UTA), who co-led the analysis. The analysis was also co-led by UTA PhD student Akshima Negi, assistant professor at the Niels Bohr Institute Tom Stuttard, and former UTA PhD student Grant Parker.



IceCube tests for fluctuations in the metric of spacetime that would break the normal rules of quantum mechanics for propagating neutrinos. The above graphic shows neutrinos interacting with virtual black holes fluctuating from the metric of spacetime, one possible mechanism of coherence loss. Credit: IceCube Collaboration

The search for decoherence as a result of quantum gravity is the latest in a series of high-energy tests for new physics delivered by IceCube, including searches for sterile neutrinos, nonstandard neutrino interactions, and neutrino decays. With the promise of a larger dataset and more precise measurements with the IceCube Upgrade and IceCube-Gen2, the search for evidence of new physics beyond the Standard Model will continue.

"In the area of quantum gravitational decoherence, the IceCube constraints are now sufficiently strong that it is unlikely that any neutrino experiment will surpass their sensitivity in the near term," says Jones. "As such, tests of gravitational decoherence will need to focus on other particles, such as electron, photon, or atom interferometry."

VERITAS — Wystan Benbow (SAO)

The VERITAS collaboration endeavors to recognize early-career scientists for outstanding work. During the past semester, Dr. Serena Loporchio (INFN Bari and University of Bari) and Matthew Lundy (McGill University) received the 2023 Trevor Weekes (post-doctoral) and Simon Swordy (graduate student) Outstanding VERITAS Contribution Awards, respectively. Both winners were recognized for numerous, wide ranging service tasks to the collaboration that are summarized on the Collaboration website.

The aforementioned VERITAS awards were presented at the semi-annual VERITAS collaboration meeting held in Tucson, AZ in January 2024. Approximately 60 scientists attended this hybrid-format event, hosted by the Project Office near the observatory. There were nearly 50 oral presentations, a poster session, and numerous discussion sessions. John Quinn (University College Dublin) was also elected VERITAS Executive Committee chairperson, and will serve a two-year term.

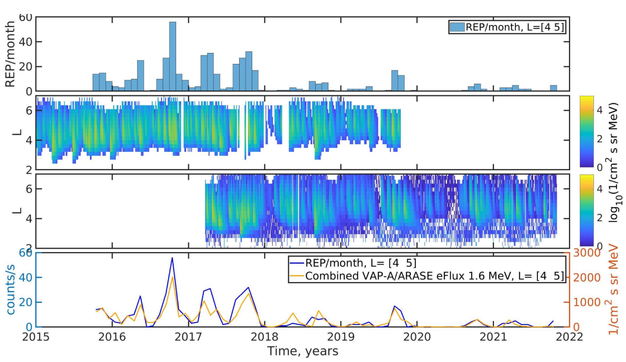
As of May 2024, VERITAS has completed $\sim$80% of its seventeenth season of full-scale operations. While the hardware systems continue to perform very well, the recent observing yields have been modest due to the strong El Nino event which leads to increased precipitation and cloud cover in AZ. The observatory is continuing its project to re-coat the mirror facets and expects to complete the first phase by the close of 2024. When complete, the total project will increase the amount of light collected by the telescopes by $\sim$50%, both decreasing the energy threshold for, and increase the sensitivity of, various observations (i.e. gamma ray and stellar intensity interferometry). The collaboration also continues preparations to secure the necessary financial support to extend VERITAS operations for another three years beyond the currently funded timeline of Summer 2025. A review of the collaboration's recent scientific and operations efforts, as well as its plans for the future, was performed by the VERITAS External Science Advisory Committee in March 2024. Preliminary feedback provided by the committee was very positive.

Since Fall 2023, the VERITAS Collaboration has published two manuscripts. The first article describes a multiwavelength study of the Boomerang pulsar wind nebula (arXiv:2310.04512). The second article details the measurement of the angular diameter of Merak (β UMa) with the VERITAS stellar intensity interferometry system (arXiv:2401.01853).

CALET JOHN WEFEL (LSU)

The CALorimetric Electron Telescope (CALET) continues to supply excellent data from its 'perch' on port 9 of the Exposed Facility of the Japanese Kibo module of the International Space Station (ISS), nearing completion of 9 years on-orbit. The project is a joint venture of Japan (JAXA), Italy (ASI) and the US (NASA). In the US, the project is led by Louisiana State University and involves Washington University in St. Louis and Goddard Space Flight Center. The main science goals are to measure the energy spectra of cosmic ray electrons and nuclei to as high an energy as possible with the total exposure available, to study high energy gamma rays and gamma-ray bursts (with a secondary CGBM instrument) and to monitor the radiation in the ISS orbit.

CALET is a deep calorimetric instrument in order to measure particle energy into the TeV region. Its top layers (CHD) are a scintillator based hodoscope (strips of scintillators in the x and y directions) designed for charge measurements. CALET also records the raw counting rates from the CHDx and CHDy detectors, and these rates provide a monitor of the radiation in orbit. These counting rates have shown "impulsive" events which are a rapid (seconds) increase in the counting rate followed by an "exponential" return to baseline. These events have the expected characteristics of MeV electron bursts and are being called REP (Relativistic Electron Precipitation) events. The CALET data can be compared to results from other spacecraft instruments operating in the magnetosphere over about half of a solar cycle.



Preliminary comparison of the REP rate seen by CALET (top panel) to the electron flux measured by Van Allen Probe-A (second panel) and ARASE (third panel) spacecraft, as function of L. The logarithmic color scheme for the spacecraft flux measurements is given by the scale on the right. The bottom plot shows the 1.6 MeV electron flux (right scale) superposed on the CALET counting rate for REP events (L=4-5) all as a function of time from late 2015 to late 2021. Credit: Sergio Vidal-Luengo.

Since the Van Allen Probe-A data end in 2019, it was necessary to also use data from the newer Japanese ARASE mission which has a mode that covers the approximately 1.6 MeV electron flux region. Note there is sufficient overlap between the missions for cross calibration. The interesting result is that when you compare the counting rates from these instruments to the CALET REP data, the agreement is surprisingly good, as shown in the bottom panel. This adds weight to the hypothesis that the CALET REP events are indeed electron precipitation events. These are probably associated with electromagnetic ion cyclotron waves, as has been suggested previously. The exact mechanism and coupling remain to be elucidated.

It should also be noted that most of the REP activity is in years 2016 – 2018. This suggests a possible solar cycle dependence to the REP phenomena. One can speculate that there is a connection between solar activity and the generation of the ion cyclotron waves which then foment the particle precipitation events that are seen deep in the magnetosphere at the ISS orbit. Turning such speculation into proven science will require continued data collection, data analysis and modeling.

Physics of the COSMOS

FRANCESCA CIVANO, BRIAN HUMENSKY & BERNARD KELLY (NASA/GSFC)

NASA's Physics of the Cosmos (PhysCOS) is one of three thematic programs that encompass NASA Astrophysics and seeks to answer the enduring question "How does our Universe work?". The PhysCOS Program Office, along with our counterparts in Cosmic Origins (COR) and Exoplanet Exploration (ExEP), will continue to engage with NASA HQ to implement Astro2020's broad vision of the next decade in astronomy.

The PhysCOS Program Analysis Group (PhysPAG) includes everyone interested in the PhysCOS program via seven Science Interest Groups (SIGs); this probably means you! Many of the SIGs have activities ramping up – please see their articles in this newsletter for details, including the Cosmic Ray, Gamma Ray, Gravitational Wave, X-ray, Inflation Probe, Cosmic Structure and the new TDAMM SIGs. The PhysPAG provides a way for the PhysCOS community to regularly engage with the Program Office. We have 15 members in the PhysPAG Executive Committee (EC), 4 of whom were onboarded at the beginning of 2024. We thank the members of the EC that rotated off at the end of 2023 – Vera Gluscevic, Grant Tremblay and Andres Romero-Wolf – for their commitment and inputs provided. We welcome our new members: Brian Grefenstette, Jeremy Perkins, Vivian Miranda, and Stephanie Wissel. The EC members organize meetings, collect and summarize community inputs, and report to the Astrophysics Advisory Committee (APAC) and NASA's Astrophysics Division Director.

The PhysCOS Program Office has been very active in the past few months collecting inputs from the community on science gaps, research areas where additional work is needed to help formulate a future mission (precursor gap) or enhance the science return of a mission in development or operation (preparatory gap), with the goal of building a science gap list including both strategic and non strategic gaps. In particular, the PhysCOS Program Office together with NASA HQ has been soliciting community inputs on precursor science gaps, relevant to Future Great Observatories, to guide the community submissions to the Astrophysics Decadal Survey Precursor Science (ADSPS) opportunity. On the PhysCOS website, a new page with details on science gaps is available as well as a form for gaps submission, which will remain open. Your inputs are all welcome!

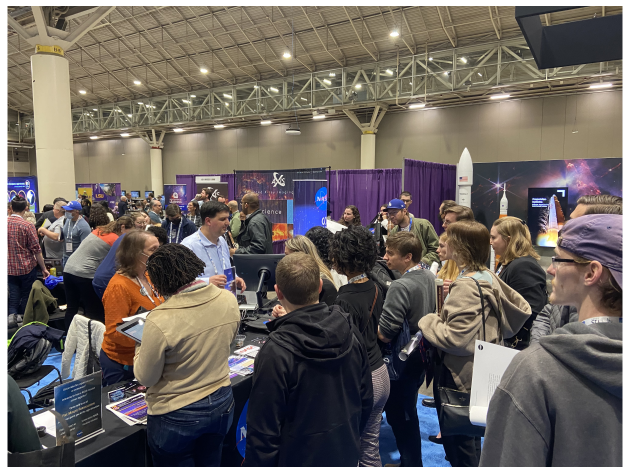
The NASA Astrophysics Technology Gap List update in 2024 is underway and our technologists are seeking input from the science community to help NASA identify gaps between today's state-of-the-art technologies and what will be needed for future strategic astrophysics missions. The PhysCOS Program Office has advertised the submissions of new technology gaps to the community and the PhysPAG EC will help the technologists to sort and reword and combine the gaps. Deadline for submission is June 3rd, 2024. More information can be found on the Current Technology Gap Priorities webpage.

PhysCOS was active at several major conferences during the last few months. At the 243rd Meeting of the American Astronomical Society in New Orleans, PhysCOS participated in the NASA Science Mission Directorate booth, introducing the office's work to scientists at all levels, distributing informational handouts, and adding more than 100 new members to the PhysCOS and associated mailing lists. PhysCOS also organized or supported oral splinter sessions for the PhysPAG, the Gravitational-Wave Science Interest Group and the Gamma Ray Science Interest Group, as well as a cross-PAG session featuring updates from the NASA Astrophysics Division Director, and a pre-conference "Astronomy on Tap" evening at a nearby venue. A full listing of our AAS activities can be found on our dedicated meeting webpage.

PhysCOS also had a presence at the American Physical Society (APS) April Meeting in Sacramento, CA (April 3 – 6), organizing a PhysPAG Minisymposium and staffing a booth throughout the meeting; and the AAS High-Energy Astrophysics Division (HEAD) Meeting in Horseshoe Bay, TX (April 7 – 12), where we organized a PhysPAG session and two individual SIG sessions (details on the dedicated webpage).

PhysCOS is planning activities at the next SACNAS National Diversity in STEM (NDiSTEM) conference, and the joint conference of the National Society of Black Physicists (NSBP) and the National Society of Hispanic Physicists (NSHP). PhysCOS is also supporting the next in the series of Time Domain and Multimessenger workshops, Multidisciplinary Science in the Multimessenger Era which will be held in Baton Rouge, LA, on September 23 – 26, 2024.

There are four PhysCOS Science Analysis Groups (SAGs) currently active and working on their findings: the cross-PAG New Great Observatories (focusing on the science case for simultaneous operations of the future Great Observatories), the cross-PAG Astrophysics With Equity: Surmounting Obstacles to Membership (AWESOM), Time-Domain And Multi-Messenger Astrophysics Communications (TDAMMComm), and Future Innovations in Gamma-rays Science Study Analysis Group (FIG SAG), which focuses on identifying future science drivers, necessary capabilities, and priorities for the future of gamma-ray astronomy.



The PhysCOS team and friends supporting the NASA booth at the 243rd AAS Meeting. Credit: PhysCOS

The PhysCOS program office is supporting the Astrophysics Cross-Observatory Science Support (ACROSS) pilot project which will provide software infrastructure, communication channels, and a help desk to improve coordination between NASA missions (and eventually other ground- and space-based observatories) for responsiveness to time domain and multi-messenger science observations.

The PhysCOS program office is always eager to hear how we can assist the community in developing and carrying out your science. Feel free to reach out to the Chief Scientists by email, ask us about PhysCOS, and look for us at upcoming meetings.

We encourage anyone interested in PhysCOS science to join our email list, where we regularly highlight items of interest to the PhysCOS community, including workshop announcements and funding or employment/internship opportunities.

Time-Domain and Multimessenger Astronomy Science Interest Group Eric Burns (LSU)

NASA's Physics of the Cosmos program in partnership with Cosmic Origins and ExoPAG has added a time-domain and multimessenger astronomy (TDAMM) Science Interest Group (SIG). We had our kickoff meeting at the 2024 Winter AAS, announcing our goals and plans and soliciting feedback from the community on what should TDAMM SIG focus on. Our first virtual meeting followed a few months later, led by a discussion with Fiona Harrison on the Decadal TDAMM recommendations and where we should focus our efforts in a productive manner. Our next planned virtual meeting will focus on transients with the Nancy Grace Roman Space Telescope, followed by a few more meetings this year. If you have suggested topics please let us know! The TDAMM SIG webpage summarizes our group, containing contact information, and email list signup insructions.

Additionally, we would like to advertise the third TDAMM workshop, Multidisciplinary Science in the Multimessenger Era, hosted at LSU September 23 – 26, 2024. This workshop will bring together scientists across astrophysics, other science fields, agencies, and disciplines in order to identify key multidisciplinary science which can be enabled with multimesenger observations of explosive transients. We seek to identify specific research topics, future focused workshops, technology and science gaps, and growth of scientist networks across barriers. More details are available on the meeting webpage.

The X-ray Science Interest Group

Kristin Madsen (NASA/GSFC), David Pooley (Trinity U. & Eureka Sci.), Chien-Ting Chen (USRA & NASA/MSFC), Brian Grefenstette (Caltech)

In response to the Astrophysics Decadal Survey Precursor Science (ADSPS) opportunity, the XRSIG EC solicited inputs from the X-ray astronomy communnity and also hosted an online discussion session. The X-ray community identified a total of 10 actionable science gaps for the future X-ray Great Observatory.

At the 2024 AAS Winter meeting, Kristin Madsen reported on the status of NewAthena, and Brian Williams gave an update on the status of XRISM. There was also a discussion hosted by David Pooley on the X-ray science and technology gaps. Prior to the 21st HEAD meeting in April, the XRSIG EC solicited contributions from the community for talks from early career researchers or talks on instruments that would not necessarily otherwise be highlighted at the HEAD meeting. This resulted in two solicited science talks on sounding rockets and CubeSAT science missions: one by Sarah Heine on "Mission Design and Development Status of the REDSoX Polarimeter"; and the other by Michael Briggs for "BurstCUBE". The XRSIG plans to continue reaching out to the early career community during future meetings.

The major news for the X-ray community is the potential decomissioning of Chandra due to NASA's updated FY2024 and FY2025 budget requests. The Chandra Users' Committee sent an open letter to NASA as a response. During the XRSIG splinter session at the 21st HEAD meeting, CfA director Lisa Kewley spoke on "The Future of X-ray Flagship Astronomy in the US", followed by an open discussion. The X-ray community expressed strong interests in forming an X-ray Flagship Science Analysis Group to address the impact of a potential loss of X-ray Flagship science. The XRSIG EC has sent out an open call for chairs and members of the X-ray Flagship Science Analysis Group with a signup form to collect potential group members. The XRSIG leadership is also in the process of drafting Terms of Reference for the next APAC meeting.

The XRSIG encourages the entire X-ray community to join the XRSIG mailing list to be informed of the progress of the Science Analysis Group and of future opportunities to present at XRSIG splinter session.To subscribe, please send an email to XRSAG-join@lists.nasa.gov with "Join" as the subject line of the email.

The Gamma-ray Science Interest Group

Jeremy Perkins (GSFC), Manel Errando (WashU at St. Louis), Justin Finke (NRL)

The Gamma-ray Science Interest Group (GR SIG) engages with the gamma-ray astrophysics community and provides a forum for discussions between this community and NASA.

The Future Innovations in Gamma-ray Science Study Analysis Group (FIG SAG) continues to have monthly meetings. This group, led by co-chairs Chris Fryer and Michelle Hui, Paolo Coppi, Milena Crnogorčević, Tiffany Lewis, Marcos Santander, and Zorawar Wadiasingh, focuses on identifying future science drivers, necessary capabilities, and priorities for the future of gamma-ray astronomy. The group held a session at the American Astronomical Society Meeting in New Orleans in January 2024, focusing on context and planning of the report the group will ultimately produce.

The GR SIG organized a session at the HEAD Meeting in Horseshoe Bay, Texas in April 2024. The meeting included an update on the FIG SAG by Milena Crnogorčević, a talk on magnetar flares by Aaron Trigg, and a talk on the gamma-ray/neutrino connection by Justin Vandenbroucke. There was also a lively discussion focusing on NASA Astrophysics Technology Gaps.

The GR SIG organized a webinar in February 2024 focusing on Precursor Science Gaps, and one in May 2024 focusing on Technology Gaps. Precursor Science Gaps represent scientific investigations needed to quantify future missions' ability to meet their science goals and assess mission design options. The Technology Gaps list is a list of technologies relevant to NASA strategic science which need to be advanced to the point where NASA's strategic science goals can be met. It can influence NASA's Strategic Astrophysics Technology (SAT) calls.

If you are interested in the GRSIG, please consider subscribing to the GRSIG mailing list. The SIG will continue organizing events at different national and international meetings and invites members of the gamma-ray community to contact the current chairs (Jeremy Perkins, Manel Errando, and Justin Finke) with any inquiries or feedback regarding the GRSIG program.

The Cosmic Ray Science Interest Group

ATHINA MELI (NC A&T STATE U.) & STEPHANIE WISSEL (PENNSYLVANIA STATE U.)

The Cosmic-Ray Science Interest Group (CR SIG) aims to act as a forum to discuss the current status of cosmic-ray and high-energy neutrino science and to provide input for NASA regarding future goals for the field.

As such, the CR SIG encourages members of the CR and neutrino astrophysics community to provide comments, questions and updates, or express an interest to give a presentation, based on their present work and future plans for cosmic ray or neutrino related research, relevant to NASA's mission.

The CR SIG plans to host a virtual forum with several speakers on the topic of "Cosmic Rays at the Knee" (mid-October, 2024). Another virtual forum is planned about "UHECRs and neutrinos" (Spring 2025). Recordings and presentation slides for all past virtual forums and meetings can be found online at the NASA PhysCOS CRSIG website.

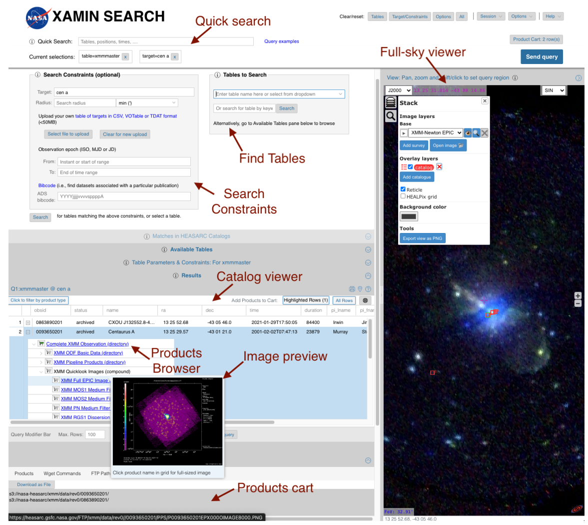
Moreover, co-chairs Athina Meli and Stephanie Wissel invite the members of the CR and neutrino community to contact them directly via email at ameli@ncat.edu and wissel@psu.edu with any inquiries or feedback regarding the NASA cosmic-ray and neutrino program.

People interested in the activities of the CR SIG are also invited to join our mailing list, available in the NASA PhysCOS website.

HEASARC

L.ANGELINI (NASA/GSFC) AND A. PTAK (NASA/GSFC)

A new Xamin interface for searching and accessing HEASARC data was released in March 2024. The Xamin web portal has undergone an upgrade in the last two years to make its interface more streamlined and user friendly, based on user input, and has been available in a beta version for the last year. Feedback is welcome. The HEASARC also continues to maintain its legacy Browse interface familiar to long-time HEASARC users.



HEASARC's new Xamin interface. Credit: HEASARC

HEASARC is moving forward with its support of cloud computing. HEASARC software and data are freely available on the science compute platform SciServer which now has several approaches to allow DS9 to be used within SciServer sessions for image analysis and region definition. HEASARC, along with other NASA archives are now available on Amazon Web Service S3 containers (see the Amazon Open Data Registry for more information).

HEASARC continues to ingest data from operating high-energy missions (CALET, Chandra, FERMI, INTEGRAL, IXPE, MAXI, NICER, NuSTAR, Swift, and XRISM). HEASARC will host BurstCube data, a GRB monitor cubesat which was deployed from the International Space Station on Apr, 18 2024 and is currently in its check-out phase.

HEASARC released version 6.33 of the HEASoft package in February 2024, and two software patches (6.33.1 and 6.33.2) in March and Apr 2024. The release included major updates of the software packages for NICER, IXPE, and small fixes for the MAXI, RXTE and Swift software. In particular, the NICER release addresses the optical light leak with an improved NICER modeling of background and responses. HEAsoftPy now uses submodules (heasoftpy.nustar, heasoftpy.heatools, etc.) to allow users to import only specific packages, which speeds up package loading. This release also includes an update for CFITSIO and XSTAR, updates for mission-independent packages and FITS manipulation packages and important updates required for building the source code on Macs using the Apple XCode Command Line Tools (CLT) version

15.3, and with GCC 14.x. See the complete 6.33 release notes and 6.33.1 and 6.33.2 patch notes for details. The next HEASoft release is planned in the summer 2024 to include XRISM software and software updates for the operating missions.

CTAO

David Williams (UCSC) &
Alba Fernández-Barral (CTAO)

The report of the 2023 Particle Physics Project Prioritization Panel (P5) in the US, released late last year, strongly supported the Cherenkov Telescope Array Observatory (CTAO). In particular, the report recommended support for "US contributions to the global CTA Observatory for dark matter" and recognized that the CTAO's "excellent energy and angular resolution play a key role in disentangling a dark matter signal from conventional astrophysical backgrounds" and that, beyond dark matter, its "broad astrophysics portfolio will provide insights into the most extreme environments in the universe and the origin and role of relativistic cosmic particles." The US groups in the CTAO Consortium look forward to working with the US National Science Foundation and other agencies to implement this recommendation.

In January this year, the VERITAS Collaboration recognized Dr. Serena Loporchio of INFN Bari and the University of Bari with the 2023 Trevor Weekes Outstanding VERITAS Contribution Award. The award recognizes Loporchio's contributions to the prototype Schwarzschild-Couder Telescope for CTAO, located adjacent to the VERITAS telescopes. (See also the VERITAS contribution to this newsletter.)

New logo of the CTAO. Credit: CTAO

In wider CTAO news, on Thursday, April 18, during the closing session of the CTAO Science Symposium at Teatro Duse in Bologna (Italy), the CTAO Managing Director, Dr. Stuart McMuldroch, officially announced the Observatory's new phase of growth. Supported by the 30M Euro endorsement by the CTAO's governing bodies in September 2023, this new period puts an end to the design phase of the Observatory, as it embarks on major infrastructure development to operate intermediate telescope array configurations in the upcoming years.

"We are moving from individual prototype telescopes to building intermediate array configurations on both sites in Spain and Chile," explained McMuldroch during his presentation. "While our goal is to reach the Alpha Configuration, these subsets will already be more powerful than any existing instrument."

"The intermediate array configurations will have a performance two to three times better than the current generation of ground-based instruments, allowing the CTAO to detect fainter sources and minute-scale variability from gamma-ray signals," says Dr. Roberta Zanin, CTAO Project Scientist.

The growth of the CTAO will not only be apparent in terms of hardware, but also software and personnel. Firstly, the Observatory will start applying advanced software packages, moving from testing to integrating key systems that control the telescopes and process data. Additionally, the CTAO Central Organisation will double its staff to support the advancement of the Observatory on all fronts, from science and engineering to computing and administration. Among the openings, the CTAO Central Organisation has currently a vacancy for Deputy Project Scientist, a key role within the Project Science Office.

To showcase this milestone, McMuldroch also launched the CTAO's new visual identity and website during his talk. An important update is that the "CTAO" will now define the Observatory and international project, discontinuing the term "CTA."

"The CTAO is built thanks to a growing international partnership composed of various teams with different tasks, scopes and even management, but who share a common goal: to build the world's largest gamma-ray observatory to achieve transformational science," says McMuldroch. "The 'CTAO' encompasses that joint effort, representing all the groups involved."

The CTAO's new logo and brand reflect this fresh phase of growth and collaboration with a clean, modern aesthetic that clearly positions the Observatory for its current and future status in the field. The website (www.ctao.org) is the most visible manifestation of this transition, providing an immersive and engaging interface for the general public and scientists to interact with the science, technology and partners behind the CTAO.

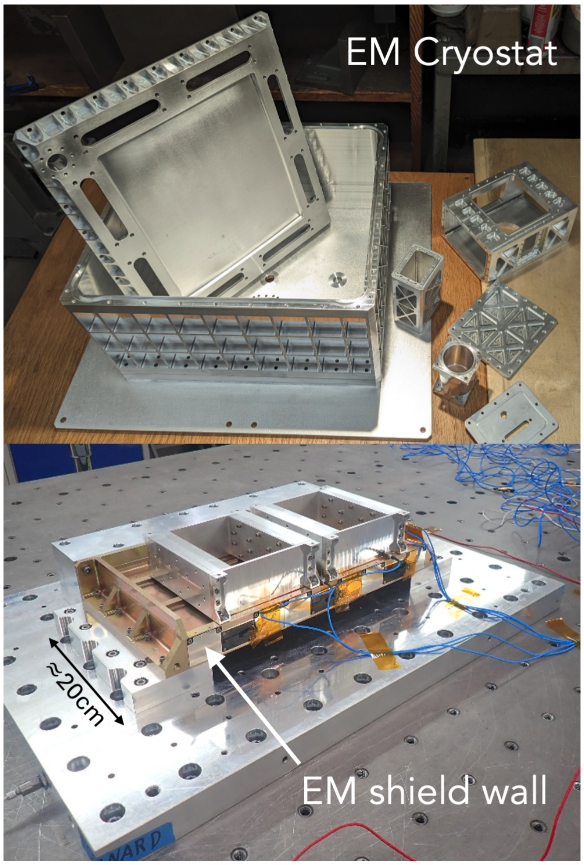
COSI: The Compton Spectrometer and Imager

John Tomsick and Andreas Zoglauer (UC Berkeley/Space Sciences Laboratory)

COSI is a NASA Small Explorer satellite mission planned for launch in 2027. With its large field of view, it will survey the sky in the 0.2 – 5 MeV band, providing all-sky (and thus all-Galaxy) gamma-ray images for studying emission lines, including the electron-positron annihilation line at 511 keV and several nuclear lines. Other COSI capabilities include polarization sensitivity and transient detection for Time Domain and Multimessenger (TDAMM) science.

The Preliminary Design Reviews (Payload and Mission

PDR) were conducted in February 2024, and the Key Decision Point (KDP) review occurred on April 16, 2024. The KDP-C Decision Memo was signed on April 16 – 17, and COSI is proceeding to Phase C. This mission confirmation marks the end of the mission formulation phase and the start of the implementation phase.



Aluminum parts for the EM cryostat assembly, including the main shell and lid on the left and parts for connecting to the cryocooler on the right Credit: Chris Smith, Brad Pafchek, Matt Rubly, Greg Dalton, Hannah Goldberg. The EM shield wall on the vibe table Credit: Alena Thompson, Lee Mitchell, Eric Wulf, Parshad Patel

The work on engineering models (EMs) is well underway, including assembly of the EM cryostat at UC Berkeley and the EM shield wall at the Naval Research Laboratory. The shield wall is made of three bismuth germanium oxide (BGO) crystals read out by silicon photomultipliers (SiPMs). A fully functional wall was assembled and passed a vibration test.

The COSI team has been working on data pipeline and analysis software and releasing yearly public data challenges (DCs). The second DC is available here. More information can be found at the COSI website.

Athena

Andy Ptak (NASA/GSFC) and Kristin Madsen (NASA/GSFC)

Athena emerged from its redefinition phase in late 2023 and is moving forward again towards mission adoption in 2027 and launch 10 years later in 2037. The mission was accepted to proceed with a slightly reduced capability (summarized below), and ESA has renamed it to NewAthena. ESA has restarted their industrial contracts on the spacecraft and Science Instrument Module, and NASA is proceeding with the technology development for X-IFU sensor and readout constribution. Other NASA contributions are: the cryocooler for X-IFU, the WFI background anaylsis, and design consultation for the WFI ASIC.

ESA's first order of business was to issue an AO for members of the NewAthena Science Study Team (NASST) and they invited NASA and JAXA to each provide a member. NASA issued a "Dear Colleague" letter and selected Laura Brenneman as the US member of the NASST. The NASST will have its first meeting in summer 2024. The main duties of the NASST will be to assist with the Phase A study for NewAthena and prepare the "red book" science proposal for NewAthena's Mission Adoption Review in 2026-2027.

The current instrument requirements that came out of the redfinition are as follows: The NewAthena mirror is currently planned to have $\sim$ 1 m^2 of effective area at 1 keV with a PSF HPD of $\leq 9''$. The X-IFU X-ray calorimeter would have a FoV$\geq 4'$ with 3 – 4 eV spectral resolution. The WFI instrument is largely unchanged from the original Athena design, with a $40' \times 40'$ FoV. Instrument response files for spectral simulation as input to the X-ray event simulator SIXTE are available on the ESA and instrument team web sites. The NASA Athena study team is supporting the availabilty of SIXTE on the SciServer computation platform.

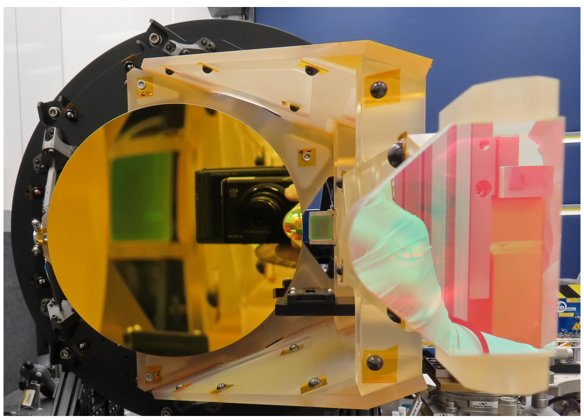
Laser Interferometer Space Antenna

James Ira Thorpe (NASA/GSFC)

The LISA mission marked a major milestone in January 2024 when it was adopted into ESA's flight program by ESA's Science Programme Committee. This marks the end of the mission definition phase and enables the transition into the implementation phase, leading to launch in the mid-2030s. ESA's decision to adopt LISA was a reflection of its science potential, technical maturity, and programmatic readiness. A comprehensive description of LISA is publicly available in the mission Definition Study Report.

With Adoption complete, the ESA project team immediately turned its attention to the selection of a prime contractor for the LISA spacecraft. In collaboration with hardware teams from NASA and ESA Member States, the team consolidated the technical requirements for the spacecraft and issued an Invitation to Tender in late March. The selection and contract negotiation process is expected to be completed by the end of the calendar year with the work beginning in early 2025.

NASA is also gearing up its LISA efforts by promoting the existing Study Office to a Project Office. This will include assigning a full Project Team and empanelling an independent Standing Review Board. The team plans a number of reviews in the remainder of 2024, leading to a Key Decision Point A/B and a transition to NASA Phase B by the end of 2024. This review process will support the development of flight contracts for NASA hardware deliverables.



Fully assembled Engineering Development Unit for the LISA telescope. Image Credit: L3 Harris Technologies / NASA

In parallel with the programmatic developments, the final elements of the LISA technology development program are being completed. In May 2024, NASA took delivery of an Engineering Development Unit (EDU) for the LISA Telescope from L3 Harris Technologies. The EDU is a quasi-monolithic all-glass telescope which is designed to meet the stringent wavefront quality, scattered light, and dimensional stability requirements for LISA. The EDU will undergo a series of tests at the Goddard Space Flight Center and the University of Florida (UF) to verify its requirements. The NASA-developed laser system and the UF-developed Charge Management Device are also nearing their TRL-6 milestones. In Europe, preparations are underway to build other key elements of the LISA instruments including the Gravitational Reference Sensor (led by Italy, with contributions from Switzerland and NASA), the Interferometric Detection System (led by Germany, with contributions from UK, France, Netherlands, Belgium, and Denmark), and the Science Diagnostic System (Spain).

The LISA science community is evolving to serve the needs of the project and prepare for science operations in the 2030s. ESA and NASA have collected applications for a joint LISA Science Team that will provide scientific stewardship for the overall mission effort. This will replace the ESA Science Study Team that served during the definition phase and the NASA LISA Study Team that provided support to NASA HQ and the NASA Study Office during the study phase. Preparations for LISA data analysis are being made through a collaboration of ESA, ESA Member States (led by France), and NASA. The goal of this combined team is the system which will convert LISA telemetry to a series of scientific data products suitable for conducting the full range of LISA science investigations. These data products will be provided to the public following a schedule defined in the LISA Science Management Plan.

The LISA Consortium is undergoing a reorganization to accommodate the needs of the flight project and the broader scientific community. The results of this reorganization are expected in late 2024. In the US, the GW Science Interest Group (GWSIG) of the Physics of the Cosmos Program Analysis Group (PhysPAG) has started a LISA subgroup with bi-weekly calls to exchange news and information. The entire LISA community is looking forward to gathering in Dublin, Ireland for the 15th LISA Symposium. This will be the first in-person Symposium since 2018 and is expected to draw a large and enthusiastic audience.

Lastly, the LISA Community is mourning the passing of Dr. Peter Bender of the Joint Insititute for Laboratory Astrophysics (JILA) in Colorado. Pete is credited with developing many of the foundational ideas for LISA starting in the 1970s and 1980s and continuing for nearly five decades. Equally importantly, Pete was a thoughtful and kind mentor to many young scientists. JILA has set up a memorial page for Pete to collect memories and tributes.

HEAPoetry Corner

Total Eclipse of the Sun

(Gather 'round) Every now and then you know the sun and the moon and this planet all align
(Gather 'round) Every now and then you know our ancestors thought that it really was a terrible sign
(Gather 'round) Every now and then they'd get a little bit nervous and they'd bang on all their pots and their pans.
(Gather 'round) Every now and then you know a few minutes later then the sun would start to peek out again.

Chorus:
Turn around dark sky, every time they thought they'd played a part.
Turn around bright sky, people really aren't always so smart.

(Gather 'round) Every now and then you know astronomers tire of the myst'ries of space-time
(Gather 'round) Every now and then you know we just want to look up at the stars and see a zodiac sign.
(Gather 'round) Every now and then I get a little bit bored and think I oughtta keep my feet on the ground.
(Gather 'round) Every now and then I get a little bit terrified the coolest stuff in space has been found.

Chorus:
Turn around dark sky, (but) ev'ry now and then I act the fool.
Turn around bright sky, the multiverse can be so damn cool,

Gonna see a Bailey's bead
Put my senses in a tumbler
Then I'll lose my mind, indeed
When we pass into the umbra
Yeah it's only a blockage of light
We've been waiting so long;

Together we will witness an event so sublime
The moon will cast a shadow on us for a short time
Photos can't explain that special kind of dark
The middle of the day and we'll be lookin' at stars.
I'm gonna freak out all right?
It's gonna be an awesome sight
It's gonna be so awesome

When the sun is blocked, the corona stays out
Other planets will join in the fun
There's nothing that compares
To a total eclipse of the sun

At totality, we'll be watching with awe
We don't need to put our solar shades on.
Cuz we're gonna see
A total eclipse of the sun.

Chorus:
Turn around dark sky, but every now and then I act the fool.
Turn around bright sky, the multiverse can be so damn cool,

(Gather 'round) Every now and then you know astronomers ti-re of the myst'ries of space-time
(Gather 'round) Every now and then you know we just want to look up at the stars and see a zodiac sign.
(Gather 'round) Every now and then I get a little bit bored and think I oughtta keep my feet on the ground.
(Gather 'round) Every now and then I get a little bit terrified the coolest stuff in space has been found.

Chorus:
Turn around dark sky, (but) ev'ry now and then I act the fool.
Turn around bright sky, the multiverse can be so damn cool,

And I want to raise a toast
To the solar-lunar nexus
And of course we thank our hosts,
Here in Horseshoe Bay, in Texas
Yeah it's only a blockage of light
But we waited so long;

Together we will witness an event so sublime
The moon will cast a shadow on us for a short time
Photos can't explain that special kind of dark
The middle of the day and we'll be lookin' at stars.
We're gonna freak out all right?
It's gonna be an awesome sight
It's gonna be so awesome

When the sun is blocked, the corona stays out
Other planets will join in the fun
There's nothing that compares
To a total eclipse of the sun.

If this ain't enough and you wanna see more
Go to North Dakota or Montan-a
in 2044, a total eclipse of the sun.
A total eclipse of the sun.
A total eclipse of the sun.

"*Total Ecllipse of the Heart*" original song written and composed by Jim Steinman; first recorded by Bonnie Tyler in 1982 and released in 1983 by CBS/Columbia; Alternate lyrics by David DuBose and Amy Mitchell Pooley