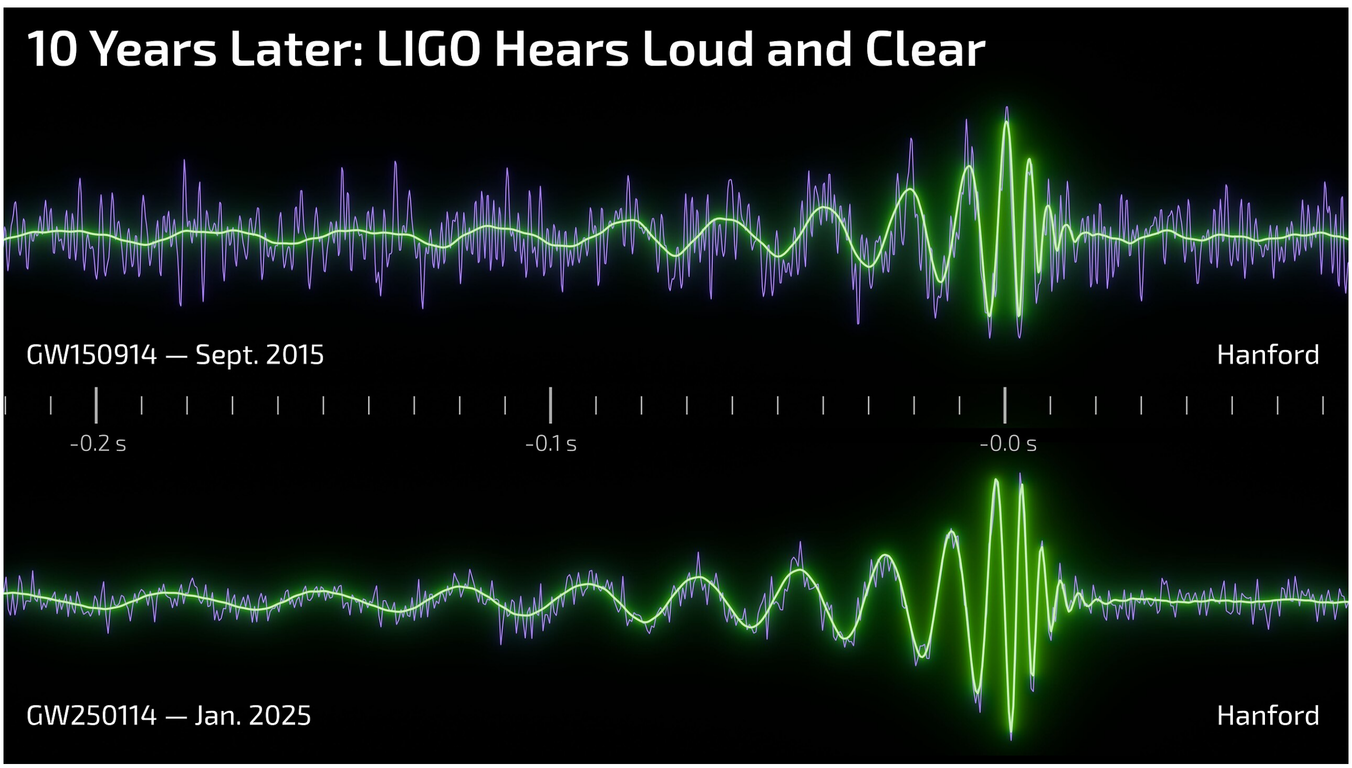
The High Energy Astrophysics Division Semi-annual Newsletter

Editors: Renee M. Ludlam (Wayne State University) and Drew M. Miles (The California Institute of Technology)

In this Issue:



Gravitational-wave signals recorded by the LIGO Hanford detector almost ten years apart. Top: data from LIGO's first detection of gravitational waves, GW150914, captured in 2015. Bottom: GW250114, captured in 2025. Both events involve colliding black holes about 1.3 billion light-years away with masses between 30 and 40 $M_{\odot}$. The purple line shows the data, which are a combination of the signal plus background detector noise. The green line shows the best-fit prediction from general relativity for each signal. The much lower noise seen today is thanks to sensitivity improvements made to the LIGO detectors over the past decade. Image credit: LIGO/J. Tissino (GSSI)/R. Hurt (Caltech-IPAC)

The View from the Chair

Kristin K. Madsen (NASA GSFC)

This will be my final "View From the Chair", and I will take this moment to say that it has been a pleasure and a privilege to have been the Chair of the HEAD for the last two years. Many changes and challenges have swept through our community, few of them positive, but I have been heartened to see that overall, we are a very resilient group. The latest stress test was the Government Shutdown, which directly affected our Executive Committee (EC) and prevented civil servants and other grant-supported employees from attending the 22nd HEAD meeting in St. Louis. Thanks to early predictions and help from the excellent AAS team, the EC made logistical choices that limited the shutdown's impact on the meeting, and in the end, all but 7(!) talks were presented.

But travel in general, particularly to attend conferences, has come under heavy scrutiny from grant givers, who, sadly, no longer see the value of attending conferences for learning and idea exchange. It has become clear that unless a person is allowed to give an oral presentation, they may not be allowed to travel. Furthermore, remote options compound this difficulty, giving travel approvers reasons to deny in-person attendance. This has changed the way that we structure the HEAD meetings, and to reduce costs, which we believe benefits our community most, we must maximize attendance by maximizing the number of in-person contributed talks. Many of our members prefer to minimize parallel sessions so they can cover all talks without prioritizing, but that has become a luxury of the past.

At the 22nd HEAD meeting in St. Louis, we decided to have three parallel sessions throughout the meeting. This worked very well and resulted in more than 200 talks. We scaled the number of topical sessions based on the number of received abstracts, and the largest number of contributed talks was submitted for Compact/Stellar Objects, AGN, and Missions and Instruments. The number of abstracts in the Missions and Instruments session came as a pleasant surprise and shows that instrument development is alive and well. It also shows that it has been underrepresented, and we are happy to rectify that.

Despite the shutdown, the 22nd HEAD meeting in St. Louis in October went very well in other aspects as well. We had just over 300 participants, down from our usual 350, and fully 1/3 of all attendees were students, many of whom were giving talks for the first time. We had a student poster competition, and congratulations to both winners:

- Julian Gerber, UC San Diego, "The Strip Pairing Algorithm for COSI's Calibration Pipeline"
- Madison Reich, Penn State University, "Systematic Monitoring of Extreme X-ray Variability of a Weak-line Quasar"

The 23rd HEAD meeting will be in 2027 (September 19-24) in Providence, RI (joint with DPS), which is a full two years from the previous meeting. This caused the EC to be concerned that students will not have any near-term opportunities to present their work, and prompted the EC to decide to plan a joint meeting with the AAS for the summer 248th AAS Meeting (14–18 June 2026) in Pasadena, CA. Both the location and the joint aspect should make it more affordable than our usual meetings. In a joint meeting, we will be running our usual topical contributed HEAD sessions, as well as some special sessions, in parallel and throughout the main AAS meeting, sharing our plenary sessions with the whole meeting, including the 2025 Early Career Prize talk by Dr. Carolyn Kierans. Please look out for the announcements.

This will be our first joint meeting with the AAS, and it will provide a valuable opportunity ahead of our HEAD meeting in Providence, which is also joint with DPS.

Finally, I would like to thank our outgoing EC members Rafaella Margutti and Javier García, and Past Chair Randall Smith for their excellent service. And please remember to vote!

News from the HEAD

Megan Watzke, the HEAD Press Officer (CfA)

While the government shutdown in the US this fall slowed down some of the news coming from NASA, the high-energy universe does not wait. There were many excellent stories that came out in the past half year, demonstrating the gamut of topics and range of discoveries made by HEAD missions. Here is a sample of some of the press releases on HEAD missions and topics that were issued in recent months.

- May 6, 2025: "NASA's NICER Maps Debris From Recurring Cosmic Crashes"
- May 28, 2025: "Eccentric 'Star' Defies Easy Explanation, NASA's Chandra Finds"
- June 19, 2025: "'The Models Were Right': Astronomers Find 'Missing' Matter"
- June 20, 2025: "Quiet Galaxy Cores Break Silence: Fermi Telescope Captures First Gamma-Ray Glow from Hidden Black Hole Coronae"
- July 24, 2025: "NASA's Hubble, Chandra Spot Rare Type of Black Hole Eating a Star"
- August 28, 2025: "NASA's Chandra Reveals Star's Inner Conflict Before Explosion"
- September 19, 2025: "XRISM Uncovers a Mystery in the Cosmic Winds of Change"
- September 24, 2025: "NASA Awards Company to Attempt to Swift Spacecraft Orbit Boost"

- November 12, 2025: "First Confirmed Sighting of Explosive Burst on Nearby Star"

XRISM

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

The X-ray Imaging and Spectroscopy Mission (XRISM), is an international JAXA/NASA collaboration with participation from ESA. XRISM began science operations in February of 2024 and in September 2024, completed the Performance Verification (PV) phase of the mission. All observations taken in the PV phase have now gone public and are available in the HEASARC archive.

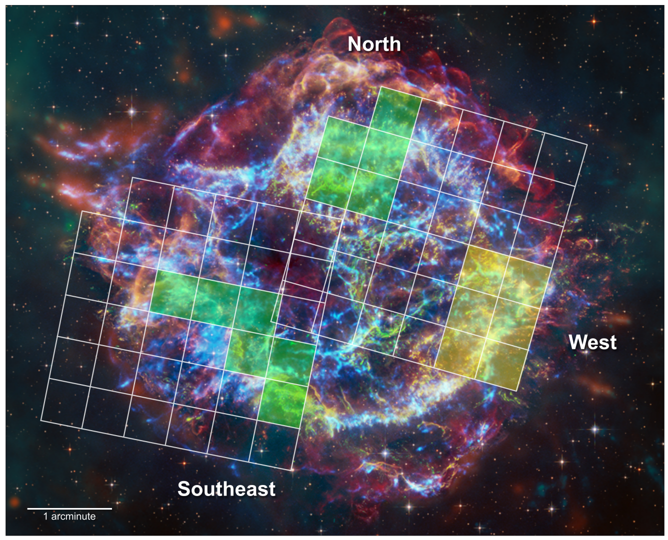
XRISM is in the General Observer phase of the mission. The deadline for observations in Cycle 2 was May 15th, 2025, and we received 300 proposals worldwide (via three parallel solicitations from the U.S., Japan, and Europe). The oversubscription rate was ~ 9.5, and the Cycle 2 approved target list is available here. The Cycle 3 Announcement of Opportunity was released on December 10th, 2025, and will be due on February 27th, 2026. Cycle 3 marks the return to a full year observing cycle, which we anticipate remaining in for the remainder of the mission. New in Cycle 3 are increased time limits for observations and joint opportunities with NuSTAR and XMM-Newton.

XRISM is performing exceptionally and 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, effectively cutting the mission off at 1.7 keV compared to the planned 0.3 keV. The Xtend instrument is unaffected. Following three attempts in 2024 to open the door, a fourth attempt was made in September 2025. Over the course of nearly two weeks, vibration was applied to the spacecraft through several cryocooler balancers on the Resolve dewar, resulting in a total of approximately 70 minutes of shaking applied to the dewar at various frequencies and intensities. Unfortunately, the door remains stuck in the closed position.

Despite this, the results above 1.7 keV are spectacular. Below, we show a spectrum of the supernova remnant Cassiopeia A. The XRISM/Resolve spectrum of this object is the most detailed yet made, and XRISM has detected, for the first time, X-ray emission lines from chlorine and potassium in the ejecta from the supernova. These elements are crucial to the formation of life in the Universe, and XRISM's ability to make these measurements helps us understand the nuclear fusion that goes on in stars before and during the supernova explosion. The paper reporting this remarkable result can be found in the December 4th issue of Nature Astronomy.

The 1st International XRISM Symposium took place October 20-24th, 2025, in Kyoto, Japan. Despite the US government shutdown that prevented attendance by NASA scientists, the meeting was a great success, with approximately 300 attendees and a full slate of talks and posters over five days. The XRISM project is planning on hosting the 2nd International meeting in the US in the spring of 2027. Stay tuned for more details, and we hope to see you there!

XRISM will have a Special Session at the upcoming Winter Meeting of the American Astronomical Society in Phoenix, AZ. We will give a status overview of the mission, and an exciting slate of speakers will review some of the recent science highlights. This session will take place on Thursday, January 8th, at 2:00 pm.



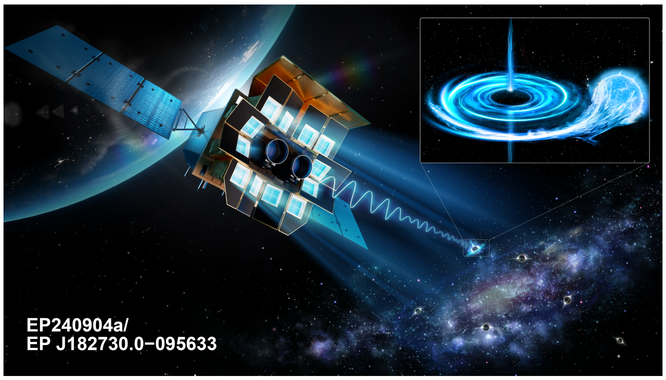
Observations of the Cassiopeia A supernova remnant by the Resolve instrument aboard the NASA-JAXA XRISM (X-ray Imaging and Spectroscopy Mission) spacecraft revealed strong evidence for potassium (green squares) in the southeast and northern parts of the remnant. Grids superposed on a multiwavelength image of the remnant represent the fields of view of two Resolve measurements made in December 2023. Each square represents one pixel of Resolve's detector. Weaker evidence of potassium (yellow squares) in the west suggests that the original star may have had underlying asymmetries before it exploded (Credit: NASA)

The Einstein Probe (Tianguan)

Weimin Yuan, Congying Bao, & Hui Sun, on behalf of the EP team

Launched in January 2024, the Einstein Probe (EP), also known as Tianguan in Chinese, commenced its routine science operations in July last year. The mission is designed to discover and characterize cosmic X-ray transients through its unique combination of a large field-of-view and unprecedented sensitivity in soft X-rays complemented with a rapid-response follow-up telescope.

To date, EP has detected over 160 X-ray transients—including approximately 130 fast transients with burst durations spanning from seconds to hours. These detections facilitate studies across various source classes, such as extra-galactic fast X-ray transients (eFXT) including gamma-ray bursts (GRBs), tidal disruption events (TDEs), and new X-ray binary systems. Notable early discoveries, highlighted in recent HEAD newsletters, include the X-ray detected high-redshift GRB detected EP240315a (Nature Astronomy) and the unusual supernova EP240414a (Nature Astronomy), the rare Be-white dwarf binary EP J005245.1-722843 (ApJL), and the peculiar transient EP240408a, which may represent a new class of explosions (Science China Physics, Mechanics & Astronomy).



Artist's impression of detecting EP240904a with EP (Credit: Sci Visual/EPSC)

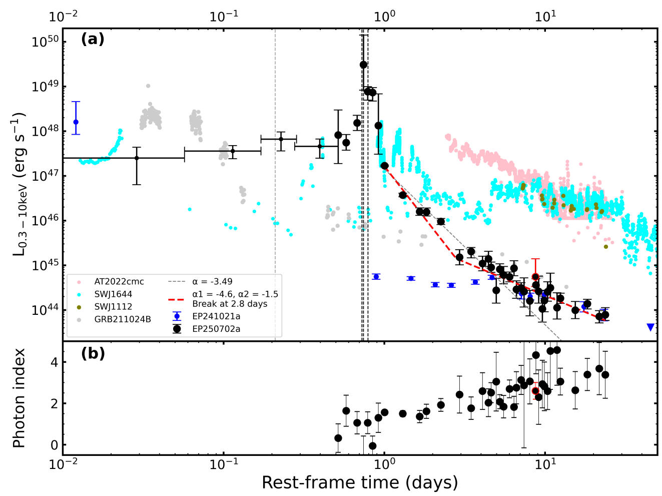
EP continues to deliver new findings. The examples below span discoveries within our Galaxy and beyond.

In the Milky Way, EP detected a faint, 20-day X-ray outburst named EP240904a (EP $J182730.0 - 095633$) in September 2024 (see artist's impression above). The event exhibited a stable non-thermal spectrum ($\Gamma \sim 2$) and a persistent millihertz quasi-periodic oscillation (~ 0.04 Hz). Combined with its inverted radio spectrum and high extinction, these properties identify the source as a faint low-mass X-ray binary, with the compact object being a strong black hole candidate. This discovery demonstrates EP's unique combination of sensitivity and field of view in unveiling hidden populations of accreting compact objects through faint transient outbursts (ApJL).

For extragalactic transients, the long-duration transient EP241021a ($z = 0.748$) exhibits a months-long X-ray afterglow, luminous multi-wavelength flares, and a stable non-thermal spectrum ($\Gamma \sim 1.8$), indicating a relativistic jet and challenging standard explosion models (ApJL). This finding has stimulated a series of quests for its origin, which ranges from core-collapse of massive stars, to neutron star merger, and to tidal disruption events. Moreover, EP has identified its first bona fide X-ray Flash (XRF), EP240801a. EP is expected to detect many more of such events. A joint analysis with Fermi measured a very soft spectral peak ($E_{peak} \sim 14.9$ keV), and follow-up secured a redshift of $z = 1.673$, enlarging the sample of these rare soft-spectrum GRBs for future study.

In the beginning of July, EP detected an extraordinary, fast and luminous X-ray transient, EP250702a, jointly with Fermi/GBM and Konus-Wind. The source reached a peak X-ray luminosity of $\approx 10^{47} - 10^{49} \mathrm{erg\,s^{-1}}$ lasting for about one day and exhibited flaring activity, with emission extending into the MeV gamma-ray range as jointly observed by Fermi/GBM and Konus-Wind, indicating the launch of a relativistic jet. The X-ray emission then dropped sharply by about five orders of magnitude within 20 days. In the late-time evolution, as the jet's hard-spectrum emission dropped to a very low flux level, a new soft component started to be revealed and to dominate the X-ray spectrum. This combination of observational characteristics is difficult to classify within any previously known category of transient phenomena.

The unique properties of EP250702a have sparked considerable interests and theoretical discussions within the community (see long-term light curve below). Among the interpretations proposed, one detailed in a recent paper submitted to Science Bulletin suggests that the event may represent the first strong observational candidate for a long-theorized phenomenon: the tidal disruption of a white dwarf by an intermediate-mass black hole, which provides a natural and plausible explanation.



(a) Long-term X-ray light curve of EP250702a compared with other X-ray transients, including jetted TDEs, an ultra-long GRB, and a jetted TDE candidate EP241021. (b) Spectral softening of EP250702a, as indicated by the temporal evolution of the photon index derived from absorbed power-law fits to the X-ray spectra.(Credit: Li, et al. under review)

Complementing these scientific findings, the public release of the first batch of EP-FXT data was made on December 11, 2025. Access to EP data is provided through multiple interfaces. In China, two primary archives are operated by the National Astronomical Data Centre (NADC) and the National Space Science Data Centre (NSSDC). Concurrently, ESA has opened the Einstein Probe Science Archive (EPSA), which provides a mirror of calibrated high-level data. The data in EPSA are processed with the latest major calibration release.

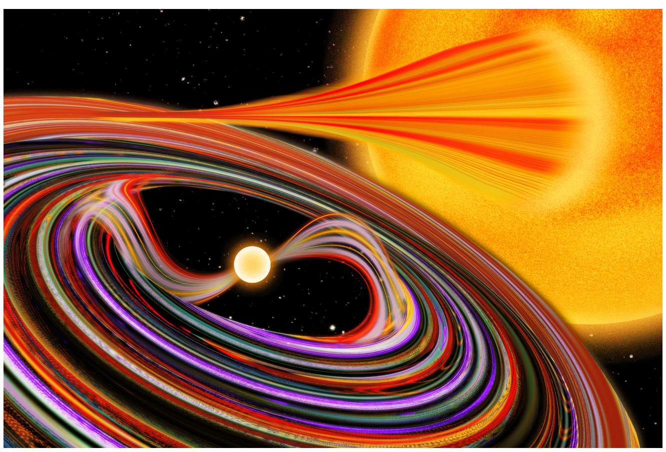
The current release includes data from the Follow-up X-ray Telescope (FXT). Public release of the first batch of data from the Wide-field X-ray Telescope (WXT) is planned for 2026.

More information on the mission can be found here.

Imaging X-ray Polarimetry Explorer (IXPE)

Philip Kaaret & Douglas Swartz (NASA/MSFC)

This issue's science highlight is the discovery of X-ray polarization from EX Hydrae, a cataclysmic variable (CV) in which the magnetic field of the white dwarf (WD) channels material accreted from the companion star into columns above the magnetic poles. Gunderson et al. (2025) detected a surprisingly high X-ray polarization degree of 8%. The offset of the X-ray polarization angle from the known optical polarization angle suggests that the polarized X-rays are scattering off a region of the WD surface near the base of the accretion column. The results enable an estimate of the height of the shock in the accretion column, which is found to be about half the WD radius. CVs are a new source class for IXPE. This discovery demonstrates the continuing power of X-ray polarimetry to provide unique insights into the physics of astrophysical objects. EX Hydrae is one of over 40 targets observed by IXPE in General Observer (GO) Cycle 2 including ten Target of Opportunity campaigns.



Accretion onto the white dwarf in EX Hydrae forms columns near the magnetic poles. IXPE probes the geometry, enabling estimate of the shock height. (Credit: Jose-Luis Olivares, MIT)

IXPE was extended for at least 3 more years following the 2025 Astrophysics Senior Review of Operating Missions. This permitted release of the annoucement of opportunity for General Observer (GO) Cycle 3. A total of 145 proposals were received for Cycle 3, marking an increase over Cycles 1 and 2 and signifying the continued strong community interest in the innovative science enabled by X-ray polarimetry. The exposure time requested was 89 Ms, a significant oversubscription relative to the 11 Ms available. The list of recommended targets is posted on the IXPE GOF website.

IXPE continues to operate nominally. However, Detector Unit 2 (DU2) experienced an event in April 2025 that changed the electronic gain of the readout ASIC. DU2 continues to function, but delivery of DU2 data has been paused until it can be recalibrated. An extensive campaign of observations for polarization calibration is planned for December 2025 and January 2026. We hope to deliver all DU2 data after the recalibration is complete and incorporated into the processing pipeline.

The 2025 NASA Senior Review required the addition of Legacy Science Projects into the IXPE observing program. The Legacy Projects were vetted by the Senior Review panel and IXPE Users' Committee. Progress in addressing these projects will be evaluated in the next Senior Review. Thus, GO proposals addressing Legacy-related science will be prioritized. The projects are: deep observation of a rapidly rotating stellar-mass black hole in the soft state to search for EVPA rotation versus energy as predicted in General Relativity, deep observation of the Crab pulsar to constrain the emission zone geometry thereby advancing our understanding of the pulse emission mechanism, observation of a high accretion rate AGN to determine the Comptonizing medium geometry, new studies of stellar-mass black hole X-ray transients through all outburst phases to measure the evolution of the accretion geometry, observation of a bright outburst of an accreting millisecond X-ray pulsar suitable for constraining the magnetic field geometry and improving constraints on the neutron star equation of state, and observation of a magnetar in outburst to search for definitive signatures of vacuum birefringence an extended campaign on Her X-1 to measure the coupling between the crust superfluid and the crust itself. We are open to suggestions for additional Legacy Projects.

Eileen Meyer (UMBC) has stepped down as Chair of the IXPE Users' Committee and Michael Nowak (WashU) has stepped up. We thank Eileen for her service. We remind readers that the IXPE Users Committee (IUC) is the primary way for you to communicate with the IXPE Project. Please use the contact form to provide feedback about the mission.

Finally, we note the retirements of Allyn Tennant, who was the IXPE Science Operations Center (SOC) lead and science planner since the start of IXPE, and Steve O'Dell, who served in several roles on IXPE including PI, Deputy PI, and Project Scientist. We thank Allyn and Steve for their indispensable contributions to IXPE. Douglas Swartz is now Deputy PI and Chien-Ting Chen is now the SOC lead and science planner.

The Chandra X-ray Observatory

Steven Ehlert (NASA/MSFC); Edward Mattison & Mark Weber (SAO)

The Chandra X-ray Observatory (CXO) marked its 26th year of operations on 2025 July 23. Now in its 27th year, Chandra continues its highly successful science mission. With its unique capability for sub-arcsecond X-ray imaging, Chandra provides essential information for accomplishing many X-ray and multi-wavelength investigations in current astrophysical research.

Chandra was one of the NASA Astrophysics missions invited to submit a proposal for the 2025 Astrophysics Senior Review, and the Senior Review panel gave Chandra an overall rating of Excellent/Very Good. Among many other compliments for the Chandra team, the panel emphasized that "The Chandra mission makes crucial contributions to all three thematic areas highlighted in the 2020 Astrophysics Decadal Survey" and that "The Chandra operating model is excellent". Such high marks would not be possible without the commitment and effort of the entire mission team.

Chandra observing time continues to be highly valued. Scientists worldwide responded to Chandra's Cycle 27 call for General Observer (GO) proposals, with 299 observing proposals requesting 66.1 Ms of telescope time. In June, the new distributed peer review system recommended 102 GO proposals for a total of 14.6 Ms observing time. (No Archive nor Theory proposals were solicited in this call, which typically result in 70–90 additional proposals.) We thank the entire Chandra community for their efforts in making the transition to a distributed peer review system as smooth as it was.

An image of the region surrounding the unique long period radio transient ASKAP J1832-0911 combining data from radio (pink/red), and infrared (yellow/white) telescopes alongside Chandra (blue/purple). (Credit: X-ray: NASA/CXC/ICRAR, Curtin Univ./Z. Wang et al.; Infrared: NASA/JPL/CalTech/IPAC; Radio: SARAO/MeerKAT; Image processing: NASA/CXC/SAO/N. Wolk)

Recent Chandra results have demonstrated the ways in which Chandra observations can be combined with other multi-wavelength data to discover new phenomena and revisit important past results. The combined data of Chandra and the ASKAP radio telescope, as an example, have uncovered never before seen emission in a long period radio transient known as ASKAP J1832-0911 shown in the associated figure. A coincident Chandra observation of this source in February 2024 not only constituted the first detection of any long period radio transient at X-ray energies, but also showed that the X-ray emission varied with the same 44.2 minute period. Six months after this detection, both the X-ray and radio emission of this source dropped by at least an order of magnitude. The connection between the X-ray and radio emission on time scales of both hours and months has never been observed in any Galactic source, and suggests the presence of an extremely unusual magnetar or white dwarf star. Further investigations of this source will be required to understand what kind of object can power such unusual radio and X-ray emission.

New data acquired with recently launched telescopes can also be combined with Chandra data to refine important past discoveries enabled by high-resolution X-ray imaging. One such example is the recent JWST observations of a classic Chandra target, the Bullet Cluster (1E 0657-56). The addition of JWST observations greatly improve the gravitational-lensing-derived mass model used to determine the location of the cluster mass with respect to the intracluster medium (the ICM, observed readily with Chandra) and the cluster galaxies observed with Hubble and JWST. The clear separation between the X-ray bright ICM (which dominates the cluster's baryonic mass) and the peaks of the mass map as determined by gravitational lensing is one of the most significant discoveries enabled by Chandra, and the new JWST data further confirm this landmark result. In fact, the new JWST data allow for better constraints on the separation between the galaxies and the dark matter and the merging history of this system.

The Chandra Observatory continues to function at or near pre-launch expectations. Incremental changes in the performance of some components continue, generally in line with pre-launch predictions and 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 scheduling tools. The gradual accumulation of molecular contamination on the UV filter that protects the ACIS detector reduces ACIS's sensitivity to low-energy (below ~ 1.5 keV) X-rays.

Chandra maintains its mission-long observing efficiency of $\approx 70\%$, close to the maximum time possible for collecting data on science targets. The main limitation on Chandra's observing efficiency is the need to protect its instruments during passages through Earth's radiation belts; in addition, spacecraft maneuvers, instrument setup and other procedures necessarily take up a small portion of the available time. The instruments must also be protected if solar radiation increases during observations. The Chandra ACIS team has developed algorithms to use the ACIS count rates to autonomously place the science instruments into a protective configuration during times of unusual background activity. The ACIS capability replaces the radiation sensing mechanisms, the EPHIN instrument and the High Resolution Camera, that were used earlier in the mission. This on-board monitoring is supplemented by space weather forecasts and data from other observatories to inform protective actions commanded from the ground. Solar activity over the past year has been among the highest recorded by Chandra since launch, making the ACIS protective capability particularly important. On 11 November, an autonomous, on-board shutdown initiated after a particularly large solar flare and coronal mass ejection protected the Chandra science instruments from radiation amounting to approximately half of their acceptable annual exposure! We take this opportunity to recognize the ACIS instrument team for developing a technique that uses the workhorse imaging CCD detector aboard Chandra as the primary real-time radiation monitor simultaneously with its function for science observation.

NASA HQ has recently formally instructed the Chandra team at Marshall Space Flight Center and the CXC to plan for FY26 using the most recent appropriations budget passed by the House of Representatives. We therefore anticipate that Chandra will have a full slate of science operations and a fully funded GO program in this new fiscal year. We are grateful to both Congressional chambers for recognizing the importance of NASA's Astrophysics fleet in general — and Chandra in particular — as a source of public good for the US and global science community, and look forward to their future support for Chandra.

We note the retirement of several core members of the Chandra team: Steve O'Dell and Allyn Tennant at Marshall Space Flight Center, Claude Canizares at MIT, and Jelle Kaastra at SRON. Steve O'Dell served as the Project Scientist for Chandra since June of 2022, and both Steve and Allyn began supporting Chandra long before its launch in 1999. Steven Ehlert is currently serving as the Acting Project Scientist. Dr. Canizares served as the Principal Investigator of the HETG instrument and the CXC Associate Director for MIT from the inception of the CXC. Herman Marshall has graciously accepted the offer to succeed in both roles at MIT. Dr. Kaastra was the PI of the LETG instrument, and Dr. Liyi Gu at SRON is now serving in that capacity. Their contributions to Chandra over the years are too numerous to list out here, but we can say without exaggeration that they were foundational and essential to the overall success of the mission thus far. We are grateful for their many years of effort to Chandra and wish them all the best in their well earned retirements.

XMM-Newton

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

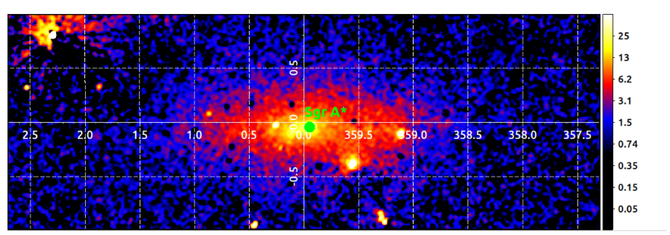
The 25th Announcement of Opportunity closed on October 10. In all, 463 proposals were received. As usual, the over-subscription factor was large – 8.6. A total of 45 proposals were received for Large Programs, and 13 for Fulfill Programs. Anticipated Target of Opportunity observations were requested in 81 proposals. Joint Programs were again very popular, with 114 proposals submitted. Of these, projects with NuSTAR, SWIFT, JWST, and HST had the most, with 38%, 17%, 17%, and 13%, respectively. Considering principal investigators and co-investigators, about 1700 individual scientists were involved in the response to the Announcement of Opportunity. The final program will be announced in mid-December, and observations will begin in May 2026.

The SOC will host the seventh meeting in the series "The X-ray Universe" on 8-11 June 2026 in Elche, Spain (about 16 miles from Alicante). It will cover a broad range of high-energy astrophysics topics, from the solar system to cosmology, and include results from a variety of current missions. Future missions and the changing scientific analysis landscape will also be discussed. Registration and abstract submission will open in January 2026. For more information, please see the SOC's website.

SRG/eROSITA/ART-XC

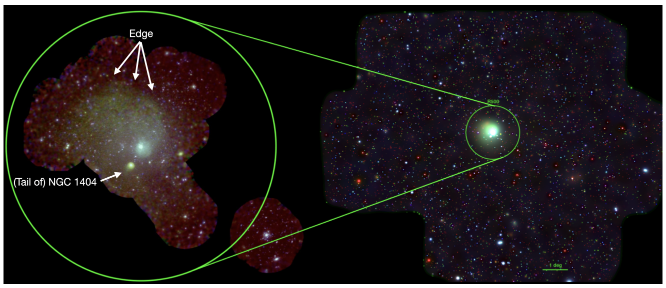
A. Merloni (MPE), A. Lutovinov (IKI), P. Predehl (MPE), & S. Sazonov (IKI)

On December 29, 2025, the Mikhail Pavlinsky ART-XC telescope will finish its eighth full all-sky survey, in line with the initial plan. The spacecraft and its payload are in excellent shape (with eROSITA remaining in safe mode). The ART-XC consortium is now preparing a program of pointed observations of selected X-ray sources and sky fields for the first half of 2026 and there are preliminary plans, currently under discussion, to resume the all-sky survey afterwards.



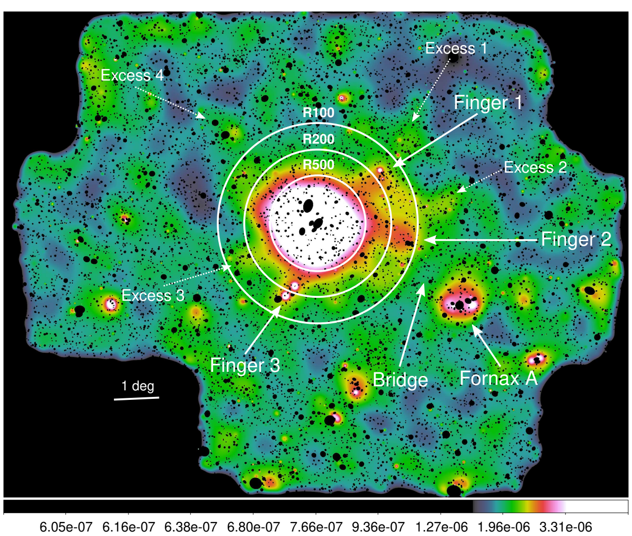
X-ray image of the Nuclear Stellar Disk and other extended stellar structures near the Galactic Center obtained by Mikhail Pavlinsky ART-XC in the 4-12 keV band (Credit: Nezabudkin et al. 2026).

On the scientific side, IKI scientists have analyzed the apparently diffuse X-ray emission from the Nuclear Stellar Disk (NSD) of our galaxy using the data of a wide-angle deep survey of this region conducted with ART-XC in 2019, during the Calibration and Performance Verification phase of SRG. It turned out that the spatial distribution of X-ray emission from the NSD closely follows the distribution of stars in that zone, but the X-ray emissivity per stellar mass is enhanced by a factor of three compared to the Galactic Ridge X-ray Emission. This suggests that the NSD X-ray emission is dominated by unresolved point sources (such as cataclysmic variables) that are on average significantly different from the X-ray source population of the Milky Way.



Left: 1.6 Ms XMM-Newton mosaic of the Fornax cluster center. Right: eROSITA All-Sky Survey (eRASS:5) observation showing the same known features in the inner regions ($\ll R_{500}$). (Credit: Reiprich et al. 2025).

Recent results from the exploitation of the eROSITA All-Sky Survey (eRASS) data include the large-scale study of the Fornax cluster, one of the X-ray brightest and most nearby galaxy clusters (Reiprich et al. 2025). The area within its virial radius, $R_{100} \sim 2.22$ deg, spans about 80 times the area of the full Moon on the sky. As a result, the existing XMM-Newton mosaic does not even cover all the area within the characteristic radius $R_{500} \sim 0.48 R_{100}$. Given its unlimited field-of-view, eROSITA is the perfect instrument to study the hot gas in the outer regions ($> R_{500}$) of this huge cluster, and beyond.



eRASS:5 image of the Fornax cluster with a color scale chosen to enhance the outer low surface brightness regions ($> R_{500}$). Quantitative analysis shows that the surface brightness between "green" and "blue" regions differs significantly. (Credit: Reiprich et al. 2025).

Previous numerical simulations of the Fornax cluster, tailored to reproduce the observed inner features, predicted a large-scale bow shock several hundred kpc south of the cluster center. The eROSITA image (see preceding figure) does not show any obvious signs for such a bow shock, though. Instead, emission extends beyond R_{500} to the west and southeast and excesses that even stretch out far beyond the virial radius are discovered. Moreover, an apparent emission bridge connecting Fornax and the nearby galaxy group Fornax A is observed by eROSITA for the first time. Altogether, thanks to eROSITA, we seem to be witnessing the ongoing growth of the Fornax cluster along preferred infall directions.

NICER

KEITH GENDREAU & ZAVEN ARZOUMANIAN (NASA/GSFC)

In the second week of June 2025, the NICER payload on the International Space Station began to exhibit signs of unexpected friction in the movement of one of its pointing actuators. The elevation-over-azimuth gimbaled pair of actuators are in constant motion during science operations, either slowly tracking a target or rapidly slewing between targets. By mid-June, the azimuth actuator could no longer be commanded to move over its full design range of motion, necessitating a halt to planned astrophysical observations. On June 17th, science operations were suspended pending additional troubleshooting; those investigations have so far not yielded a solution. Science operations remain suspended and, in coordination with overall ISS operations, the NICER team is currently focusing its efforts on stowing the payload.

In September, 50-plus proposals were received for Cycle 8 of NICER's General Observer (GO) program; given the inability to conduct new observations with the NICER payload, Cycle 8 was focused exclusively on investigations proposing analysis of archival data. As of this writing, dual-anonymous peer review of proposals has been completed, and we expect results to be announced in January 2026. All users are encouraged to explore the rich trove of data resulting from 8 years of continuous NICER operations, with observations often made in rapid response to transient phenomena. As improved background models and filtering algorithms enable gains in sensitivity and expand the reach of existing data, we anticipate many new discoveries will be possible through archival analysis.

NICER data analysis software is distributed through the HEASoft package; the latest release, 6.36, incorporates NICERDAS 15, which offers tools and calibration products that accommodate the upgraded detector readout configuration (and content of data files) implemented during March and April to address the consequences of the May 2023 "light leak" and its repair, to recover as much scientific utility as possible. End-to-end analysis threads, tools, and documentation are available for the generation of spectra, light curves, and background estimates based on the sophisticated SCORPEON model. Feedback on NICERDAS performance is welcome through the HEASARC helpdesk system.

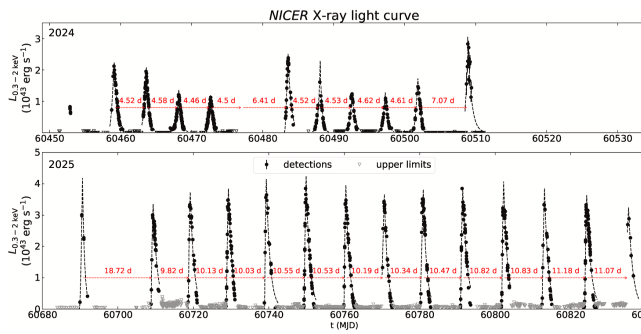
A special session organized by HEAD at the 247th AAS meeting in Phoenix, AZ on the morning of Tuesday, January 6 will be devoted to highlights of the broad range of scientific contributions made by NICER to date. We thank HEAD for the opportunity to showcase NICER's legacy in this way, and look forward to seeing many HEAD members there.

Recent NICER science results include:

- Continued pioneering discoveries involving quasi-periodic eruptions (QPEs) of soft X-rays from the cores of an increasingly diverse sample of galaxies. A goldmine of phenomenology, the QPE source known as "Ansky" continues to surprise: already exceptional upon its discovery in 2024 for its brightness and the duration and long repetition period of its eruptions, NICER's high-cadence monitoring revealed that Ansky's periodicity and eruption duration both doubled in 2025 (see figure to the right and Hernandez-Garcia et al. 2025). The implications of these remarkable changes remain under investigation for both scenarios that have been proposed to explain QPEs: accretion-disk instabilities and "extreme mass-ratio inspiral" systems in which a stellar-mass object (or the debris stream of one that has been disrupted) is interacting with the accretion disk around a supermassive black hole. At the same time, NICER confirmed eruptions from a 5th suspected source based on sparsely-sampled observations with eROSITA (Arcodia et al. 2025).

- Novel explorations of quasi-periodic oscillations in black-hole binaries, including multiwavelength correlations and the discovery of "imaginary" QPOs. Vincentelli et al. (2025) find some of the highest-frequency optical/IR QPOs yet seen in observations of Swift J1727.8−1613 that were strictly simultaneous with NICER, establishing X-ray-to-Optical/IR variability lags with implications for models of disk-jet interactions. Similarly, spectral-timing cross-spectrum analysis of soft (disk-dominated) vs. hard (coronal) X-rays are revealing heretofore unknown variability features that probe the physical mechanism connecting an accretion disk and nearby Comptonizing plasma (Fogantini et al. 2025; Bollemeijer et al. 2025).

- Further evidence for ashes of thermonuclear burning in the winds emanating from powerful Type-I X-ray bursts. Jaisawal et al. (2025) compile data for 15 short bursts from the ultracompact binary 4U 1820−30, as well as the aftermath of a candidate superburst seen by MAXI in 2021. They find a set of consistent spectral lines, in emission and absorption, near the photospheric radius expansion phases of most of these events. The emission line, near 1.0 keV, remains fixed, but the absorption lines—at energies consistent with Si, Ar, Ca, and other elements—exhibit small energy shifts likely due to Doppler effects and gravitational redshifts. The heavy-element features may originate in the explosive wind or could indicate temporary metal enhancement in the flow of accreted matter.



X-ray luminosity, measured with NICER, of the galactic-nucleus emission nicknamed "Ansky," May 19 to June 20, 2024 (upper panel), and January 7–June 11, 2025 (lower panel). Black points represent detections, open triangles are upper limits; dashed traces model best-fit exponential rises and decays. The average interval between eruptions in 2025 is twice as long as that in 2024. Observations in the second half of 2024 were largely Sun-constrained. (Credit: Hernandez-Garcia et al. 2025)

Neil Gehrels Swift Observatory

S. Bradley Cenko (NASA/GSFC)

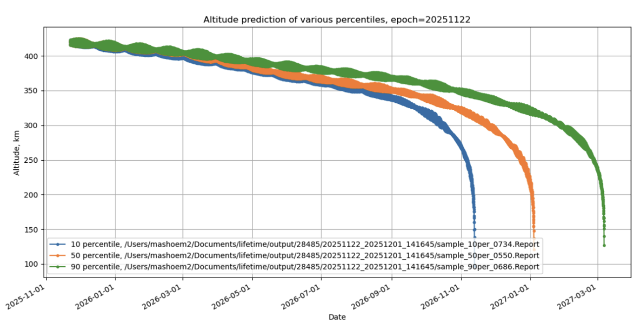
NASA's Neil Gehrels Swift Observatory continues to operate exceptionally well. The mission supports five Target-of-Opportunity (ToO) requests per day from the community, in addition to observing gamma-ray bursts (GRBs) and Guest Investigator (GI) targets. *Swift* is by far the most active mission in terms of number of ToOs accepted and different sources observed.

Swift received 172 GI proposals in response to the Cycle 22 call, an increase of 15% over Cycle 21, and the second largest number overall in the last decade. Proposal reviews will take place over the week of December 8–12, and we anticipate notifications will be sent to proposers in late January or early February 2026. Cycle 22 observations will begin April 1, 2026.

Following its passage behind the Sun, *Swift* has recently resumed observations of the interstellar object 3I/ATLAS. Previous *Swift* UVOT observations of the source obtained in July and August 2025 first revealed the presence of hydroxyl (OH) gas, a chemical fingerprint of water. *Swift* detected OH when the comet was nearly three times farther from the Sun than Earth — well beyond the region where water ice on a comet's surface can easily sublimate. At those distances, most solar-system comets remain quiet. The strong ultraviolet signal from 3I/ATLAS suggests that something else is at work: perhaps sunlight is heating small icy grains released from the nucleus, allowing them to vaporize and feed the surrounding cloud of gas. The results were reported in Xing et al. (2025).

Like all satellites in low-Earth orbit, *Swift's* altitude has steadily declined since launch due to atmospheric drag. Over the course of the last year, this orbital decline has accelerated more rapidly than anticipated due to larger than expected solar activity - solar flares and coronal mass ejections heat the Earth's atmosphere, resulting in an increased density (at a fixed altitude). Initially launched to an orbital altitude of 600 km, at the time of writing *Swift's* altitude has dropped to ≈420 km.

Ultimately, without a propulsion system on-board, the *Swift* satellite will re-enter Earth's atmosphere. Our team has worked hard to understand when re-entry will occur, refining models based on predictions for solar activity levels. At the time of writing, absent any modifications to our observing profile, our best estimate of the re-entry date is between November 2026 and March 2027 (80% confidence interval; see figure below). We caution, however, that such predictions are inherently uncertain, due both to modeling limitations and stochastic solar variability.



10% (blue), 50% (orange), and 90% (green) confidence predictions for Swift's altitude evolution, assuming no modifications to the observing profile. Credit: M. Shoemaker (NASA GSFC/SSMO).

Recognizing the potential loss to the scientific community, as well as a unique opportunity to stimulate the US commercial space industry, NASA has funded Katalyst Space Technologies to launch a mission to rendezvous and capture *Swift*, and raise it to a higher altitude. The Katalyst reboost mission is currently slated for launch in June 2026, and, if fully successful, would extend the orbital lifetime of *Swift* by at least a decade. More information about the reboost effort can be found here.

Since contract award in late September, the *Swift* team has been working tirelessly to support Katalyst in its development efforts. We anticipate in the coming months further testing of capabilities needed for rendezvous and capture, which will by necessity result in reduced time available for science observations. Similarly, we are actively exploring options to reduce drag and prolong the orbital lifetime, which would similarly reduce available science time. We will endeavor to provide regular updates to the broader community throughout this process, via Community Update meetings, as well as posts on the GSFC Swift website.

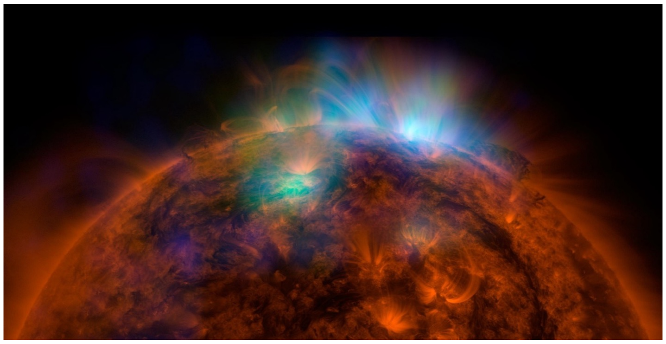
NuSTAR

Hannah Earnshaw & Karl Forster (Caltech); Daniel Stern (JPL)

A major milestone for the NuSTAR mission was reached this Fall with the implementation of automated systems that will reduce the response time to high priority, rapid-response Target of Opportunity (ToO) triggers from 48 hours to less than 6 hours. The number of ToO proposals submitted to NuSTAR to study transient phenomena has steadily increased over the last decade and the mission has responded by expanding the allocation of ToO time. This year more than 40% of all proposals selected for NuSTAR investigations are for ToO investigations. Until recently, the response to the triggering of these observations has been a manual process undertaken by the operations teams at the Science Operations Center (SOC) at Caltech and the Mission Operations Center (MOC) at UC Berkeley. A rapid response to transient events has only been possible during working hours and on a few occasions when staff had been available on evenings and weekends. Over the last few years, automated systems have been developed at the SOC and MOC which enable generation and upload to the spacecraft of a new command sequence, containing the instructions to observe approved rapid-response targets once a ToO observation is triggered. This is a major adjustment to the standard operation of the NuSTAR mission, and we expect, on average, less than six hours between the triggering of a rapid-response ToO observation and NuSTAR collecting data on that target. In favorable cases, NuSTAR could be collecting data within an hour of a ToO trigger.

The new rapid-response capabilities are available to the Principal Investigators of Cycle-11 ToO programs and may be proposed for in the upcoming Cycle-12 Guest Observer (GO) program where a rapid response is scientifically justified. The Cycle-12 GO program also introduces joint XRISM time, with up to 500 ks of XRISM time available for coordinated observations. NuSTAR time will conversely be available through the XRISM Cycle-3 call for proposals expected in 2026. NuSTAR GO proposals are due on January 29, 2026 at 4:30 pm EST, and the observations will begin in June 2026.

On the science front, several papers were released over the past few months detailing how NuSTAR has been used in the search for dark matter by placing limits on the properties of the theorized axion particle. Axions are predicted to be generated by the interaction of a high-energy photon with the electric fields of an atomic nucleus or electron in the extremely hot, dense environment in the core of a star, converting back into a high-energy photon when interacting with the star's magnetic field outside of its surface. By searching for the predicted X-ray signals of this process from the Sun (Ruz et al. 2025), massive stars like Betelgeuse (Candón et. al. 2025a), and even nearby star-forming galaxies (Candón et al. 2025b; Ning & Safdi 2025), limits have been placed upon the mass and matter coupling parameters of axions. A recent article on the NuSTAR website explains more.



High-energy emission from active regions on the Sun's surface, with 2–5 keV X-rays captured by NuSTAR in blue and green, overlaid on a Solar Dynamics Observatory image in red. Placing limits on the X-ray emission outside of active regions allows the constraining of axion properties. (Credit: NASA/JPL-Caltech)

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)

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 www.hxmt.cn (in English and Chinese).

Some new important results have been published recently with *Insight*-HXMT data. Studies of the new black binary transient Swift J1727.8–1613 have revealed the ejection of transient jets (Wood et al. 2025), identified the dip-like feature in the spectrum (Jin et al. 2025), tracked the evolution of the QPO (Wei et al. 2025), performed the detailed broad-band spectral-timing of QPOs (Bollemeijer et al. 2025) and the spectral analysis of the X-ray flares in the outburst (Cao et al. 2025). We also performed the spin measurement of the black hole SLX 1746-331 (Chen et al. 2025), flux variations and torque reversals of Cen X-3 (Liu et al. 2025). Additionally, we have released the first *Insight*-HXMT localization catalog of short-duration Gamma-Ray Bursts (Xiao et al. 2025), reported gamma-ray counterpart of X-Ray transients detected by EP/WXT (Zhang et al. 2025), and unveil the TGF-lightning relation with a large sample of TGFs (Yi et al. 2025). All corresponding observational data are publicly accessible (http://archive.hxmt.cn/proposal), and we encourage in-depth investigations with these data. Please visit *Insight*-HXMT's publication list for more details.

AO-07 of *Insight*-HXMT finished on Aug. 31, 2025, AO-8 Cycle Proposal Evaluation has been completed and announced. In total 991 observations from 48 proposals have been approved. In particular, some observation time has been reserved for joint HXMT-EP observations. See the long-term and short-term plans, and list of observed sources for more information about Insight-HXMT observation plan. Finally, *ad hoc* ToO observations can be proposed by anyone at anytime (www.hxmt.cn), and the data are normally open immediately unless special request is made and approved by the PI.

GECAM

SHAOLIN XIONG, CHENWEI WANG, WENJUN TAN, YUE WANG, SHUXU YI, SHIJIE ZHENG (IHEP), CE CAI (HEBNU), YANQIU ZHANG (GZNU)

GECAM constellation has been working as a network of gamma-ray all-sky monitors composed with three members, GECAM-A, GECAM-B and GECAM-D (i.e. DRO/GTM) since February 13, 2025 when GECAM-C (i.e. SATech-01/HEBS) ceased operation as the satellite reentered. GECAM-B extended its daily observation to about 20 hours since its solar panel recovered in November 2025.

With unique observation data of GRB 230307A (the brightest ever GRB of merger origin) by GECAM-B and GECAM-C, a remarkable feature of 909 Hz periodicity is found in a short time window (160 ms) during the prompt emission (Chen et al. 2025). Such high frequency is well consistent with the theoretical prediction of millisecond magnetar as the central engine of GRB. Therefore, this result serves as a direct evidence of the millisecond magnetar central engine.

Moreover, based on the GECAM non-saturation observation data of GRB 230307A, the collective behavior of fast pulses of GRB 230307A was found to resemble a classic self-similar FRED (Fast-Rise-Exponential-Decay) profile, which supports the scenario that the prompt emission of this burst comes from many mini-jets in a magnetically dominated jet (Yi et al. 2025). This event also indicates that the dissipation and prompt emission may not occur simultaneously in a large zone, but sequentially triggered by propagating magnetic perturbations. In such scenario, an impulsive short-duration energy injection from central engine can result in a long-duration GRB (Yi et al. 2025).

Additionally, with the GECAM observation data, GRB 230307A is also found to be one of the GRBs with the most number of distinguishable pulses. By analyzing the temporal and spectral properties of these pulses, a set of properties including the pulse flux, waiting time of adjacent pulses, pulse width and spectral peak energy, are found to evolve exponentially with time. These results imply that a relativistic jet is colliding with more slowly expanding material. This contrasts with the standard internal shock model for typical long GRB, in which dissipation occurs at random locations within the jet itself (Maccary et al. 2025).

With the increasing number of "long" GRBs with merger origin (such as GRB 211211A and GRB 230307A), we found there is a subclass of Type I GRB, named as Type IL GRB, which features an intrinsically long-duration main burst (Wang et al. 2025). The energy ratio between extended emission and main emission for these Type IL GRBs is found to be ~ 0.7, which is different from the traditionally long short burst thus provides important clues in understanding the mechanism of Type IL burst. A complete criterion to identify such Type IL GRBs based on light curve is established, and more type IL GRB candidates are found from the archival data (Tan et al. 2025). Such criterion for rapid recognition of Type IL GRBs has already played an important role in initiating low-latency follow-up observations as these Type IL bursts are originated from binary merger thus are Gravitational wave (GW) sources.

Detection of short gamma-ray bursts (SGRBs) is crucial for studies of compact object merger in multi-messenger astrophysics, but SGRB events may fall below trigger thresholds and are therefore missed by previous observation. With the Energetic Transients Joint Analysis System for Multi-INstrument (ETJASMIN) framework, a systematic search and verification of SGRB candidates from Fermi/GBM sub-threshold triggers by jointly analyzing data from GECAM-B and GECAM-C has been implemented (Cai et al. 2025). Among 466 GBM sub-threshold events with reliability ≥ 5 from 2021 to 2024, 181 fall within GECAM's field of view and 49 are confirmed as astrophysical transients, of which 41 are classified as SGRBs. Including these GECAM-recovered bursts improved the Fermi/GBM SGRB detection rate from ~ 40 to ~ 50 per year. It is projected that a more complete multi-instrument follow-up of GBM sub-threshold triggers could further increase the SGRB rate to ~ 80 per year.Moreover, a search for temporal coincidences between SGRBs and GWs reported by LIGO–Virgo–KAGRA O4 run finds no match, underscoring both the rarity of multi-messenger events and the importance of coordinated observations and multi-instrument pipelines.

Within the ETJASMIN framework, a systematic search for gamma-ray counterparts to the 63 fast X-ray transients detected by Einstein Probe/WXT during its first year of operation is implemented (Zhang et al. 2025). Jointly analyzing data from GECAM-B, GECAM-C, Fermi/GBM and Insight-HXMT, gamma-ray counterpart candidates are found for 14 out of 63 X-ray transients. It is revealed that the soft X-ray (0.5–4 keV) emission systematically precedes and lasts longer than the associated gamma-ray emission. X-ray transients with gamma-ray counterparts tend to have higher peak flux in the soft X-ray band, though their duration and average flux show no distinct preference compared to the full sample. Spectral analysis indicates that the gamma-ray counterparts are relatively soft, while their duration and fluence do not exhibit significant difference from normal GRBs. In addition, an inverse correlation between the 0.5 and 4 keV fluxes of X-ray transients and the fluxes of their gamma-ray counterparts is reported.

By systematically analyzing 159 magnetar X-ray bursts (MXBs) from SGR J1935+2154 detected by GECAM-B between 2021 and 2022, a new light-curve pattern, named as "exponential rise and cutoff decay" (ERCOD), was found (Wang et al. 2025). This pattern, featuring an exponential rise followed by an abrupt cutoff decay, is morphologically distinct from the well-known fast rise exponential decay (FRED) profile. Analysis reveals that ERCOD-type bursts generally exhibit longer duration, higher peak fluxes, and harder spectra compared to FRED-type bursts. This discovery suggests that ERCOD represents a fundamental pulse shape in MXBs, indicating more powerful energy release mechanism of magnetars.

Although GECAM is primarily designed for time-domain astronomy, the dedicated design also give it the ability to detect and identify particle precipitation events especially those with extremely high flux or rapidly temporal evolution structures. A novel method for pitch angle measurement for GECAM was proposed and validated by detecting a short duration particle events (Wang et al. 2025). Moreover, a new kind of particle precipitation events, named as oscillating particle precipitation (OPP) events, which exhibits significant periodicity in the flux, are also unveiled by GECAM (Wang et al. 2025). Thanks to the high-resolution observation of GECAM, several interesting temporal and spectral features of these particle precipitation events are revealed for the first time, including the modulation in the hardness ratio and significant evolution of spectral lag. All these demonstrate the promising potential of GECAM in space physics research.

The Fermi Gamma-ray Space Telescope

Elizabeth Hays, Andrea Prestwich, Judy Racusin, Dave Thompson (GSFC); & Lynn Cominsky (Sonoma State)

The *Fermi* scientific instruments, Gamma-ray Burst Monitor (GBM) and Large Area Telescope (LAT), continue to survey the entire gamma-ray sky. During November, one of the LAT event processors began resetting frequently. The resets caused gaps in planned observations between November 5 and 13. The processor was then taken out of service to restore stable operation. The spare event processor will be brought fully online in the coming weeks to restore full onboard processing capacity. The current configuration does not cause significant science impacts.

A new analysis technique allowed detection of Seyfert galaxies in the *Fermi*-LAT data. These radio-quiet sources produce gamma rays in dual-structure coronae. See here for further details.

Observations by the GBM of the longest GRB ever observed imply an ultra-relativistic jet from a long-lived stellar-mass central engine. The data might be explained by a helium merger, where a field binary ends when a black hole falls into a stripped helium star and proceeds to disrupt it from within. More information can be found here.

In June, *Fermi* conducted the first target of opportunity (TOO) observation since 2018. The mission team has restored the ability to conduct pointed observations while meeting observatory safety and power constraints. Nova V462 Lup provided an ideal opportunity to exercise the new procedure. *Fermi* reclaimed coverage and detected the onset and decay of gamma-ray emission during times that the nova would have remained mostly outside the LAT field of view in the planned survey. *Fermi* is accepting TOO requests from the community. Proposed observations with a strong science justification and measurable improvement from the observation will be considered. For more details be visit the *Fermi* TOO website.

For the LIGO/Virgo/KAGRA O4 runs, given the very wide fields-of-view of both instruments and their sensitivity to gamma-ray bursts, the instruments have emphasized maintaining high uptime. The teams are alerting the community about possible counterparts. Both the GBM and LAT teams post GCN Notices and Circulars for gravitational wave counterparts or for constraining upper limits. The LAT team reports automatic follow-ups to alerts: here.

Fermi software and documentation are available through the Fermi Science Support Center. Fermitools v2.4.0 was released in April. 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 available on GitHub as a package in the Gamma-ray Data Tools.

Find details about the Guest Investigator program at the Fermi Science Support Center. The Cycle 19 proposal deadline will be **January 29, earlier in the year than previous cycles.** A workshop for proposers will be held on January 13. Proposers considering including TOO observations are strongly encouraged to contact the FSSC help desk or the project scientists to discuss feasibility and performance.

The 2025 *Fermi* Summer school was held from May 27 to June 6, 2025. The 2026 Fermi Summer School is planned for May 26 to June 5, 2026. The portal for applications will open in January. Interested graduate students and post docs can find more information about the program and application process on our website.

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.

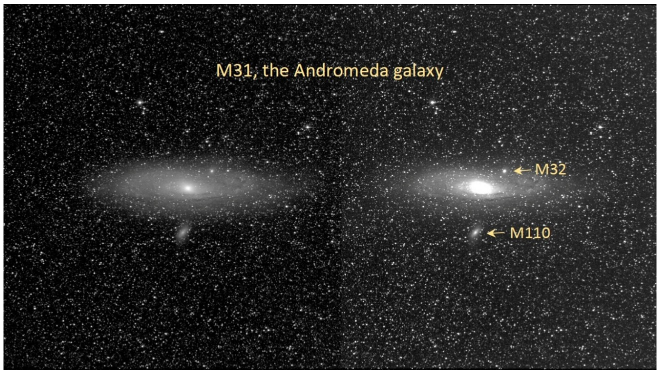
INTEGRAL: Optical Monitor Camera (OMC) Legacy Image

J. MIGUEL MAS-HESSE (CAB, CSIC–INTA), JAN-UWE NESS (ESA), & STEVEN STURNER (NASA-GSFC, UMBC)

The Optical Monitoring Camera (OMC) was one of the instruments onboard the ESA INTEGRAL mission, launched in October 2002. It consists of an optical refractive system focused onto a large format CCD detector (1024×1024 pixels image area) working in frame transfer mode, with a wide field of view of 5×5 square degrees. OMC provided the optical counterparts of the high-energy sources observed by INTEGRAL, and also serendipitously monitored more than 100,000 potentially variable sources within its field of view. A set of technical tests were performed prior to switching off the instrument in order to verify its performance by comparing images with reference images taken during the commissioning phase. Furthermore, the de-icing procedure was tested by activating the baking heaters during almost 3 days (Mas-Hesse et al. 2025), to get experience in the removal of contaminants from the surface of the CCD.

The optical performance of the OMC has remained very stable during the last 22+ years. The continuous monitoring and calibration of the instrument during this time had already shown that the sensitivity had decreased by just a mere 3–4%, indicating the radiation-hard lenses have not been affected by a significant darkening induced by radiation at the INTEGRAL orbit. Furthermore, the optical performance has also remained very stable, with a Point Spread Function (PSF) within 1.3 ± 0.1 pixels throughout the 22+ years of operations. The CCD itself has also withstood the harsh space conditions in pretty good shape: the average dark current has increased, as well as the number of hot pixels, but no columns have been lost and it has continued to provide high quality data until the last day. Finally, baking the CCD apparently decreased its dark current, but only to a certain extent, not recovering the original values. The OMC performance was confirmed after 22+ years by comparing a picture of the Cyg X-1 region with a similar image taken during the commissioning phase. Despite the internal ageing effects of the CCD, the visual inspection of both images does not show any significant difference. Finally, a beautiful last–light image was taken of M31, the Andromeda galaxy, for legacy outreach of the INTEGRAL

Optical Monitoring Camera.



Legacy OMC image of M31 (Andromeda galaxy), pictured with 2 different contrast scales: Left contrast gives insight on the nuclear part of the galaxy, Right: contrast shows more details of the diffuse stellar arms and the dusty regions. (Image credit: Mas-Hesse et al. 2025)

In recognition of INTEGRAL's importance in the Interplanetary Network, a knowledge transfer workshop was held on 3 July 2025 to discuss the basic telemetry data that can still be provided by INTEGRAL. Three institutions have since requested access to this telemetry data. The data flow of remaining telemetry has been reenabled to the INTEGRAL Science Data Centre (ISDC) on 11 September 2025, while the other two institutes (CNES Toulouse and Saclay) are in progress.

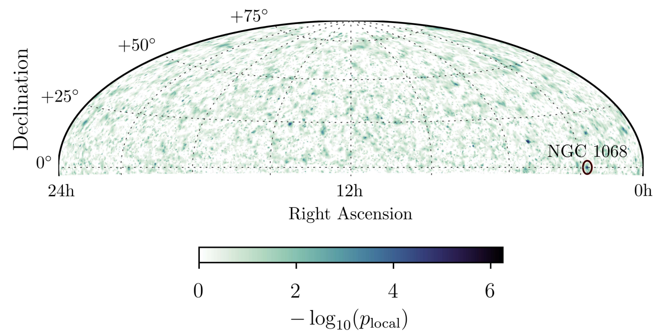
IceCube

ALISA KING-KLEMPERER (UW-MADISON)

In 2022, the IceCube Neutrino Observatory at the South Pole announced evidence for high-energy neutrinos spewing from the "nearby" active galaxy NGC 1068, one of the brightest X-ray sources in the universe.

X-rays shine brightly in the immediate surroundings of the supermassive black hole that powers NGC 1068. At the same time, gamma rays, which are typically used as a guide in IceCube's searches for neutrino sources, are not detected at comparable levels with neutrinos in this source. In AGNs like NGC 1068, X-rays can escape the dense environment around the supermassive black hole and provide information about its properties while gamma rays are absorbed. Neutrinos could also form if particles are accelerated and subsequently interact with the X-rays in this environment.

Using 13 years of IceCube data, the IceCube Collaboration did a follow-up search for additional X-ray-emitting galaxies as a source of high-energy neutrinos. The study had two key findings: NGC 1068 remains the most significant neutrino source in the northern sky, and a population of newly selected galaxies revealed evidence for neutrino emission from similar sources. These results are presented in a paper, "Evidence for Neutrino Emission from X-ray Bright Active Galactic Nuclei with IceCube", recently submitted to *The Astrophysical Journal Letters* by the IceCube Collaboration.



IceCube's p-value map of the northern sky, obtained under the hypothesis of a free spectral index. The map is shown in equatorial coordinates on a Hammer-Aitoff projection. The color bar represents the local significance of each pixel in the sky, and we highlight the location of the strongest emission, found to be spatially compatible with the Seyfert II galaxy NGC 1068. (Credit: IceCube Collaboration)

"The NGC 1068 observation marked one of the few times we'd seen such a clear neutrino signal from a galaxy powered by a black hole," says Tomas Kontrimas, who was a PhD student at Technische Universität München (TUM) when he contributed to the work. "But it also raised an important question: is NGC 1068 unique, or just the first of many galaxies capable of producing neutrinos?"

The researchers focused on the northern part of the sky where neutrinos travel through the Earth before arriving at IceCube. The Earth acts as a natural shield, blocking most background cosmic rays and, therefore, providing a clean view of neutrinos arriving from space. Similar to a 2024 study, they looked at X-ray-emitting active galaxies that could also be linked to high-energy neutrino production.

"To improve on previous work, we focused on galaxies that were emitting "hard" X-rays in the 20–50 keV range, which can penetrate the dense gas and dust that often obscure a galaxy's core," explains Chiara Bellenghi, TUM postdoctoral researcher and study lead. "Using these criteria, we selected 47 X-ray–bright AGNs from the Swift/BAT Spectroscopic Survey (excluding NGC 1068) and tested each one as well as the whole group for neutrino emission."

They observed an excess of neutrino emission from the selected population with a statistical significance above the 3σ threshold.

"This new evidence suggests that NGC 1068 is not an isolated case, but rather part of a broader class of active galaxies that produce high-energy neutrinos," says Elena Manao, a PhD student at TUM who contributed to the work. "This is a significant step toward identifying one of the population of sources responsible for the cosmic neutrinos detected on Earth."

The IceCube Collaboration is not stopping here, however, as some of the most promising nearby X-ray–bright

AGNs lie in the southern sky, where they face more background noise but also hold discovery opportunities. Future improvements in data processing and detector calibration will no doubt boost IceCube's sensitivity in that area.

These efforts will help better understand the mechanisms that generate neutrinos in the extreme environments around supermassive black holes, bringing them closer to revealing how the universe's most energetic particles are produced and accelerated.

VERITAS

WYSTAN BENBOW (SAO)

The eighteenth season of VERITAS operations closed in June 2025, and was particularly successful. Excellent sky conditions at the observatory and a continuation of the project's outstanding hardware reliability resulted in the largest data yield in 7 years. Near the season's end, VERITAS held a face-to-face collaboration meeting (a hybrid-format event) at the University of Utah. This well-attended meeting (∼50 attendees) included ∼60 oral presentations, a poster session, lightning talks, hands-on small-group working sessions, and a joint CTAO planning session. The presentations (∼55% by junior scientists) formed the basis of the papers presented by the VERITAS Collaboration at 2025 conferences. The 39th International Cosmic Ray Conference (ICRC2025) was emphasized by the project and 22 papers were presented by the collaboration. Highlights from these conference presentations included the VERITAS discovery of VHE emission from the iconic quasar 3C 273 and from the blazar RGB J1243+364.

In September 2025, VERITAS began its nineteenth season of full-scale operations. Following a generally dry summer monsoon season, the array was brought back online after the annual ∼3-month pause without any major issues. Over the summer, the project performed significant maintenance to the array. One highlight was the replacement of a large number of mirror facets with freshly re-coated glass. This ongoing project has increased the whole-dish reflectivity of three VERITAS telescopes by ∼20%; the fourth telescope will be completed this winter. By increasing the amount of light collected by the telescopes, we are maximizing the science achievable with VERITAS.

We are expecting strong yields this season due to a La Niña phenomenon which typically leads to warm, dry weather in AZ. Indeed, after two months of operations, the initial observing yields are the strongest in VERITAS's history and it is clear the hardware systems are performing well. This should continue to enable a suite of Galactic and extragalactic gamma-ray studies, growth in the stellar-diameter catalog from the intensity interferometry program, and significant multi-messenger collaboration. Highlights from this season's observations include the detection of a VHE flare from the blazar 1ES 1959+650, which triggered a larger multi-wavelength observation campaign including IXPE and Swift, and the follow up of a significantly higher number of gamma-ray bursts via the inclusion of triggers from SVOM and the Einstein Probe.

Observatory operations are currently funded through Summer 2026, and the Project Office is working to secure the necessary financial support to extend VERITAS site operations.

Since Spring 2025, the VERITAS Collaboration has published three journal articles. The first article describes a multi-wavelength study of a candidate pulsar halo LHAASO J0621+3755 (arXiv:2504.02185). The second manuscript reports an in-depth multi-wavelength study of the gamma-ray binary HESS J0632+057 (arXiv:2507.23304). The third article details VERITAS, HAWC, Fermi-LAT, and XMM-Newton observations of the unidentified gamma-ray source LHAASO J2108+5157 (arXiv:2508.01934). The collaboration also has four manuscripts that are in press, and another three that are undergoing review at the journal.

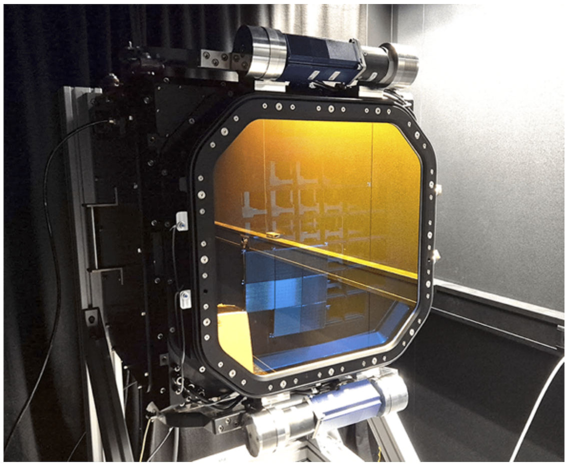
Cherenkov Telescope Array Observatory (CTAO)

DAVID WILLIAMS (UCSC) & ALBA FERNÁNDEZ-BARRAL (CTAO)

The U.S. teams involved in the development of the CTAO have been awarded a $3.9 million grant from the National Science Foundation (NSF) to contribute to building and installing ten cameras for the Small-Sized Telescopes (SSTs). Led by the Washington University in St. Louis and the University of Wisconsin–Madison, the funds will provide silicon photomultiplier (SiPM) photosensors for the telescopes located on the CTAO-South site in Chile, as well as the readout and control electronics required to operate them.

The SSTs are the smallest of the CTAO's three telescope types that the Observatory will use to cover its broad energy range, from 20 GeV to 300 TeV. They will outnumber the other telescopes, with 37 SSTs planned in the approved Alpha Configuration and spread across several square kilometers on the CTAO-South array. Their large collection area makes them essential for extending CTAO's sensitivity to the highest TeV energies, enabling study of the most energetic cosmic accelerators in our Galaxy.

The SST's design permits a compact camera based on SiPM sensors. Each camera's 32 SiPM tiles account for a total of 2,048 pixels, covering a large field of view of approximately 9 degrees across. The camera records Cherenkov light in 128-frame movies, with each frame lasting one billionth of a second.



SST camera prototype with a quarter of its full array of pixels installed. (Credit: Richard White, MPIK).

With the new NSF funds, the CTAO-US teams will become significant contributors to the CTAO SST Collaboration, the in-kind contributors responsible for building this class of telescopes. The development and installation of these ten cameras will enhance the Observatory's capabilities at the highest energies and marks a significant step in the U.S. teams' participation in the project.

The U.S. members have been deeply involved in the CTAO project since its inception more than a decade ago, contributing across governance, scientific, and technological domains. They participated as an Observer in the CTAO gGmbH, the former legal entity of the Observatory prior to the establishment of the ERIC in January 2025. Negotiations regarding U.S. accession to the ERIC are currently ongoing. In November this year, the CTAO-US Consortium selected the Smithsonian Astrophysical Observatory to represent the U.S. groups in the negotiations and to host the project office for U.S. activities for the CTAO. Additionally, the CTAO-US teams have been active members of the CTAO Consortium, the group dedicated to the science exploitation of the Observatory, holding key managerial positions, including that of Co-Spokesperson.

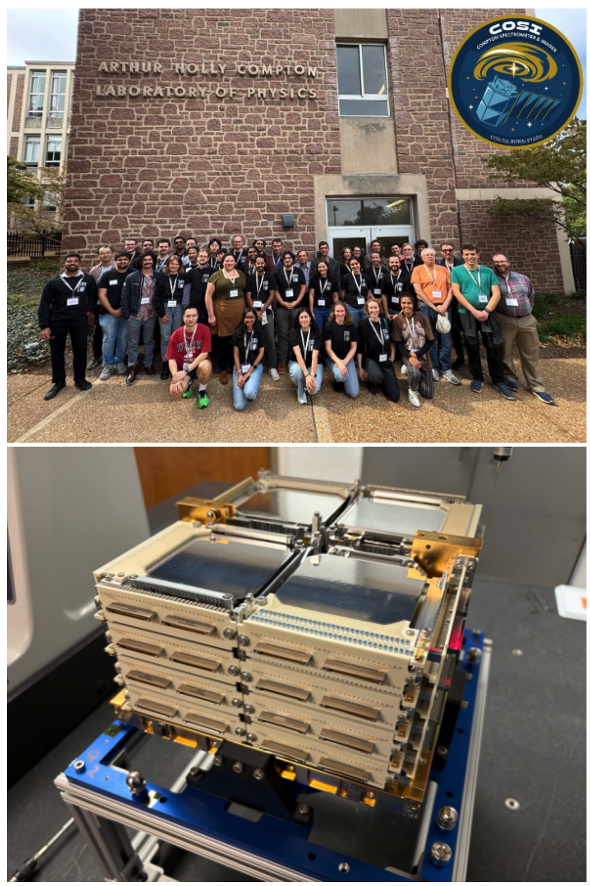
They are also engaged through in-kind contribution collaborations, with a particular focus on the design of an alternative structural configuration for the Medium-Sized Telescopes, known as the Schwarzschild-Couder Telescope (SCT), featuring an innovative dual-mirror optical system. This optical design was first conceived by CTAO-US members in 2006, and a prototype was inaugurated in 2019 at the Whipple Observatory in Arizona. The new NSF funds will now enable them to build cameras for the SST, which incorporates the same dual-mirror optical system and a very similar camera design featuring many of the same components as the SCT.

In a separate development, during its fifth meeting in November 2025, the CTAO ERIC Council unanimously approved a revision of the CTAO ERIC Statutes to formally include Switzerland and Croatia as full members, granting them corresponding voting rights. The CTAO ERIC members now include Austria, Croatia, the Czech Republic, the European Southern Observatory (ESO), France, Germany, Italy, Poland, Slovenia, Spain, and Switzerland. Further countries — Australia, Brazil, Japan, South Africa, and the United States — are engaged in the process of joining the CTAO ERIC.

COSI: The Compton Spectrometer and Imager

JOHN TOMSICK & ANDREAS ZOGLAUER (UC BERKELEY/SPACE SCIENCES LABORATORY)

COSI is a NASA Small Explorer gamma-ray mission planned for launch into low-Earth orbit in 2027. Using an array of 16 germanium detectors (GeDs), COSI covers the 0.2–5 MeV energy band with high spectral resolution along with wide-field imaging. These capabilities allow for advances in studies of the electron-positron annihilation line at 511 keV and nuclear lines across the Galaxy. In addition, COSI measures the polarization of gamma rays from accreting black holes and will provide rapid reports of gamma-ray burst positions for time domain and multimessenger (TDAMM) science.



(Top) COSI Science Team members at COSIfest in front of WashU's Compton Hall. (Image credit: Samantha Tippett). (Bottom) 16 GeDs loaded into the FM detector holder assembly. (Image credit: Christopher Smith and Matt Rubly).

In the past months, COSI has had several scientific and technical highlight. Many COSI Science Team members attended the HEAD meeting, which included a COSI Special Session. This was followed by the "COSIfest" meeting of the COSI Science Team hosted by Washington University, St. Louis (thank you, WashU!!!). Many people attended COSIfest (see top image in the associated figure), which included science presentations from the six Science Topical Teams (positrons, nucleosynthesis, Galactic, extragalactic, gamma-ray bursts, and dark matter). On the technical side, COSI reached the milestone of having 16 GeDs tested and loaded into the flight model (FM) detector holder assembly (see bottom image), and integration of the FM COSI payload is proceeding. Finally, we would like to remind the HEAD community that one way to get involved in COSI is through participation in the COSI data challenges (DC3, DOI 10.5281/zenodo.15126188).

NewAthena: Revealing the Hot and Energetic Universe

Andy Ptak & Kristin Madsen (NASA/GSFC)

NewAthena, formerly known as Athena, is an ESA L-class mission selected for study in 2014 for the Cosmic Vision Program. NewAthena successfully passed an Intermediate Review (IR) during the summer of 2025, a critical gateway to ensure that everything is on track going toward the MAR. A recent European Ministerial meeting explictly endorsed NewAthena as one of ESA's priorities (see press release here). NewAthena is on track for adoption in 2027 and launch in 2037 (more mission timeline details are here).

The NewAthena mission consists of two main instruments: the Wide-Field Imager (WFI) and the X-ray Integral Field Unit (X-IFU). The WFI will simultaneously provide imaging over a wide field (40$\times$40 arcmin) with spectrally and time-resolved photon counting. The WFI sensor is a DEPFET (depleted p-channel field effect transistor) with a pixel size of 2.2 arcsec and an energy resolution of $\leq$170 eV at 7 keV. The X-IFU is an X-ray calorimeter that combines high spectral resolution with high-quality imaging. It has an approximate field of view of 4 arcmin, a pixel size of 5 arcsec, and an energy resolution of $\leq$4 eV at 7 kev. A mirror with a diameter of 2.3 m that is populated by Silicon Pore Optic (SPO) modules and capable of achieving more than 1 m^2 of effective area at 1 keV focuses at 12 meters onto one of the two instruments at a time. It is shifted between the two focal planes by a hexapod upon which it is mounted.

As the NewAthena mission approaches the Mission Adoption Review next year, the verification of the revised NewAthena science requirements takes center stage and is the responsibility for which the NewAthena Science Study Team (NASST; list of members) was assembled. There are 33 science requirements, 17 of which were revised during the reformulation. Eight were identified as Driving Science Objectives (DSO), and one new DSO was identified on the measurement of the neutron star equation of state. The NASST is tasked with confirming that the current instrument design meets these scientific requirements. It is also the responsibility of the NASST to compile the 'Red Book', which is the document that describes the science case to the ESA Science Program Committee during the MAR. They will be supported by the Science Working Groups (SWGs) in this effort. The NASST recently issued a call for a community-contributed special A&A issue to lay the foundations for the Red Book. The NASST is currently finalizing the list of paper titles selected to be included in the A&A special issue with paper drafts due by Fall 2025.

NASA is contributing the X-IFU sensor and readout and, since the redefinition, the cryocooler for X-IFU. For the WFI, NASA is contributing background analysis work and design consultation for the WFI ASIC. NASA is also providing a vibration isolation system for launch. All NASA contributions have been progressing well.

You can keep up-to-date with NewAthena via the NewAthena community website, or through the Twitter handle @AthenaXobs and via Facebook. To find out more about the science enabled by the instrument and the technology, explore the NewAthena Science Nuggets and Tech Nuggets.

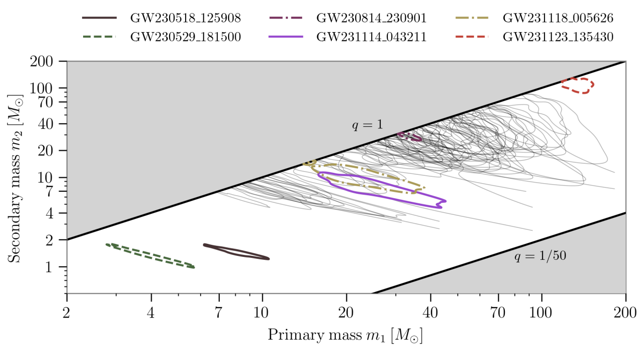
LIGO-Virgo-KAGRA Collaboration

S. Fairhurst (Cardiff University) & P. Shawhan (University of Maryland)

The LIGO, Virgo, and KAGRA gravitational-wave detectors ended their fourth observing run (O4) on 18 November 2025, completing the longest and most sensitive run yet for the laser-interferometer detector network. The two LIGO detectors (at Hanford and Livingston) operated with a sensitivity of 140–180 Mpc in terms of binary-neutron-star merger range. The Virgo detector operated with a sensitivity of 30–60 Mpc and KAGRA operated at 1–10 Mpc during periods of the run. In 2025, excluding a commissioning break in April and May, Virgo and both LIGO detectors were observing simultaneously about 35% of the time.

The LIGO-Virgo-KAGRA Collaboration (LVK) identified over 250 gravitational wave candidate events during the O4 run with low latency searches. As offline analyses are completed with improved understanding of detector performance and noise background, the list of candidates is expected to change and their estimated source properties may also shift.

The LVK has publicly released the data from the first part of the fourth observing run (O4a), which ran from May 2023 to January 2024. The gravitational wave strain data and catalog of observed events are available at GWOSC. The full list of LVK papers is maintained at this link.



The 90% credible-region contours for the inferred primary and secondary component masses m_1 and m_2 of compact binaries observed through gravitational waves. Colors highlight specific candidate events with masses and/or spins lying at the edges of the observed population. Taken from the GWTC-4.0 catalog result paper.

The GWTC-4.0 catalog includes all events observed from O1 to the end of O4a. It contains 218 gravitational wave candidate events which have at least 50% probability of astrophysical origin, of which 128 are from O4a. The O4a data include three exceptional events which have been described in dedicated papers:

- GW230529: A binary merger of a neutron star and an object lying in the "mass gap" ($3 - 5\,M_\odot$) between neutron stars and known black holes.
- GW230814: The loudest event observed from O1 to the end of O4a, with a signal to noise ratio of 42 in the LIGO Livingston detector.
- GW231123: The most massive black hole binary merger observed to date, consistent with at least one of the black holes being in the pair instability mass gap ($\sim 60 - 130\,M_\odot$).

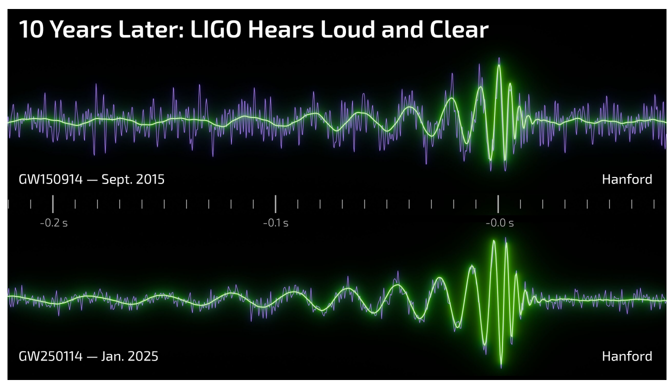
The GWTC-4.0 catalog also allows for improved inference of the astrophysical population of stellar-mass black black hole binaries. In particular, we observe clear overabundances in the mass distribution at 1–2 $M_\odot$ and around $10\,M_\odot$, and a feature near $35\,M_\odot$, with no conclusive evidence to either support or refute a suppression of the merger rate between these features. We find that black holes with masses around $35\,M_\odot$ preferentially pair with companions of similar mass more frequently than lower-mass black holes do. We find that the distribution of effective inspiral spin, $\chi_{\rm eff}$, is skewed toward positive values. Black hole (dimensionless) spin magnitudes span a broad range from 0 to 1, although 90% of black holes have $\chi < 0.57$.

The LVK has also released results from searches for un-modelled transients in the data. While these searches are able to detect a fraction of the merging binary black holes, there are not yet any observations of transient gravitational wave signals of non-binary origin.

Searches for continuous gravitational-wave signals have provided upper limits on the ellipticity of known neutron stars observed as pulsars and unknown neutron stars in binary systems. In addition, they have constrained dark matter models, both through the potential direct interaction of dark matter with the detectors and through searches for gravitational waves emitted by boson clouds formed around black holes.

Searches for a stochastic background of gravitational waves enable limits of on cosmological backgrounds at a level of $\Omega_{\rm GW} < 3 \times 10^{-9}$ for a flat spectrum. These searches also allow thresholds to be placed on various cosmological models for gravitational-wave formation in the early universe, as described in this paper.

The LVK has announced two major discoveries from the O4b run period (April 2024 to January 2025). The first is the loudest GW event observed to date, GW250114, with a network signal-to-noise ratio over 80. The observed signal is very similar to that of the first observation, GW150914, as shown in the figure below, and the higher SNR can be attributed to improvements in the detector sensitivity over the past decade. The high SNR of the event enabled accurate determination of the binary parameters, as well as unprecedented tests of General Relativity and the nature of black holes.



Gravitational-wave signals recorded by the LIGO Hanford detector almost ten years apart. Top: data from LIGO's first detection of gravitational waves, GW150914, captured in 2015. Bottom: GW250114, captured in 2025. Both events involve colliding black holes about 1.3 billion light-years away with masses between 30 and 40 $M_\odot$. The purple line shows the data, which are a combination of the signal plus background detector noise. The green line shows the best-fit prediction from general relativity for each signal. The much lower noise seen today is thanks to sensitivity improvements made to the LIGO detectors over the past decade. Image credit: LIGO/J. Tissino (GSSI)/R. Hurt (Caltech-IPAC)

The second O4b result is an analysis of GW241011 and GW241110, a pair of unequal-mass binary black hole mergers in which at least one of the black holes is rapidly rotating. The more massive black hole in GW241011 exhibits one of the most rapid and precisely measured spins observed to date, with $\chi = 0.78^{+0.09}_{-0.09}$. The observed unequal masses and high spins are consistent with binary formation through hierarchical merger.

The LVK has recently announced plans for a six-month observing run to begin in late summer/early fall of 2026. Detailed plans are being developed and will be shared with the astronomy community on the web and through other channels.

Laser Interferometer Space Antenna

KRISTA LYNNE SMITH (TEXAS A&M), JOEY SHAPIRO KEY (UW BOTHELL), & JAMES IRA THORPE (NASA/GSFC)

The *LISA* mission is now firmly in its implementation phase. In June 2025, ESA announced the selection of OHB System AG as the prime contractor for the LISA spacecraft; OHB will lead a team of European aerospace companies to develop and build the three identical LISA spacecraft. Each spacecraft will house scientific instruments provided by ESA Member States and NASA that will work together to measure the effect of gravitational waves washing across the LISA constellation.

These instrument providers are transitioning from the late stages of technology development to the early stages of flight model procurement. Industrial partners are on board for many items and the details of the final design and development are being worked out. This includes physical interfaces, delivery schedules, integration and test plans, etc. Progress is being consolidated through a series of reviews including Preliminary Design Reviews (PDRs) at component and system level. Launch is on track for 2035.

Work is also ramping up on the LISA ground segment, with ESA starting to staff its mission and science operations teams. These agency teams join the large community of researchers in the scientific community who have spent decades developing approaches for LISA's scientific data processing. As with the spaceflight hardware, the responsibility for the ground segment will be shared by ESA, participating ESA Member States, and NASA. These partners will develop a robust system to convert the LISA telemetry into a set of scientific data products suitable for conducting the full range of LISA science investigations. A major focus of 2026 will be a simulated data analysis campaign organized by the LISA Distributed Data Processing Center (DDPC). This campaign will allow all of the involved groups to develop and test prototype analysis codes against a common set of assumptions informed by the current best estimates of mission performance and a fairly simple, but diverse, model of the astrophysical environment. The analysis products developed during this campaign will also give researchers a preview as to what future LISA data will look like, which will inspire the development of scientific investigations.

The LISA Science Team (LST) is now established as a group of European and American experts working with ESA and NASA to provide scientific guidance to the mission. The LST has established a number of working groups to make recommendations on data releases, science investigations, and publication policies as described in ESA's Science Management Plan for LISA. The LST is building interfaces with the broader scientific community through participation in scientific conferences, newsletters like this one, and regular interaction with the LISA Consortium.

After successfully supporting the adoption of LISA as a mission in the ESA Science Programme with support from ESA Member States and NASA, the LISA Consortium has reorganized itself to serve the interests of the mission and the scientific community during the implementation and operations phases. A reorganization is now complete and the group is accepting applications from persons interested in contributing to or following the progress of the mission.

As a final note, like much of the NASA science program, support for US contributions to LISA was not included in the FY2026 President's Budget Request released in late May 2025. This led to a period of uncertainty for US involvement in the mission over the summer. Supporters of LISA and NASA science advocated strongly against the proposed cuts and their calls were heard when appropriations bills in both the House and Senate specifically included funding for NASA's contributions to LISA in addition to other NASA science programs. While these bills await passage by Congress, NASA is implementing the House version of the bill, in which LISA is fully funded.

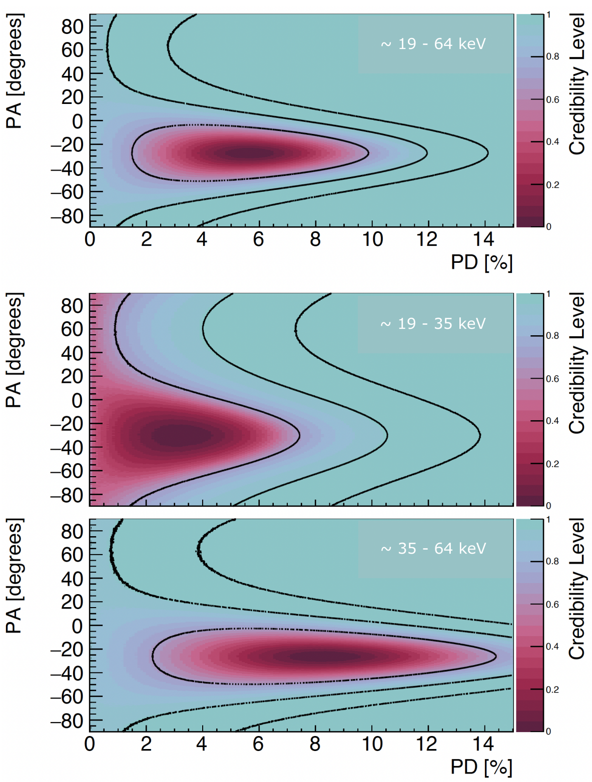
XL-Calibur: Crab and Cygnus X-1 Results and HESARC Data Release

EPHRAIM GAU (WASHU), JACOB CASEY (UNH), SEAN SPOONER (UNH), FABIAN KISLAT (UNH), KUN HU (UNH), MÓZSI KISS (KTH), HIROMITSU TAKAHASHI (HIROSHIMA UNIV.), YOSHITOMO MAEDA (JAXA/ISAS), HARUKI KURAMOTO (OSAKA UNIV.), MARK PEARCE (KTH), TAKASHI OKAJIMA (GSFC), ERIC WULF (NRL), SCOTT HEATWOLE (WFF), & HENRIC KRAWCZYNSKI (WASHU) FOR THE *XL-Calibur* TEAM

XL-Calibur is a balloon-borne hard X-ray polarimetry mission for the ∼15–60 keV energy range. The experiment uses a 12 m-focal length telescope with a scattering polarimeter at the focus of the spare hard X-ray mirror from the Hitomi mission and is pointed by the Wallops Arc-Second Pointer (WASP). The polarimeter consists of a cylindrical 12 mm-diameter 8.1 cm long high-purity beryllium scattering element surrounded by 0.8 mm thick Cadmium Zinc Telluride (CZT) detectors read out by Application Specific Integrated Circuits (ASICs) developed at the Naval Research Laboratory positioned inside a 3 cm wall thickness BGO anti-coincidence shield. The telescope was launched on July 9, 2024 from Esrange, Sweden and flew in 5.6 days to northern Canada. The stratospheric balloon flight was used to observe the black hole X-ray binary Cygnus X-1 and the Crab nebula and pulsar. The team has now published results from both sources, and publicly released event by event data on the

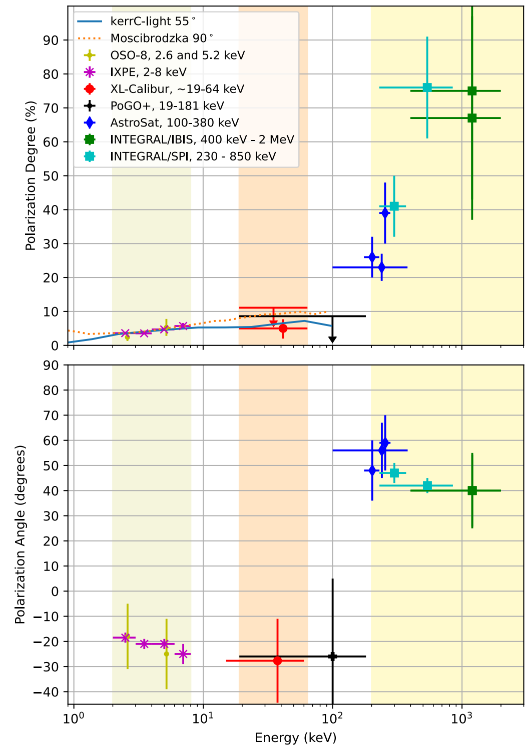
HEASARC.

Cyg X-1 results: The paper describing the Cygnus X-1 results, [*XL-Calibur* polarimetry of Cyg X-1 further constrains the origin of its hard-state X-ray emission], was published in ApJ on 13 November 2025. The *XL-Calibur* observations constrain the 15-60 keV hard state Polarization Degree (PD) and Electric Field Vector Polarization Angle (PA) to $5.0^{+2.7}_{-3.0}$ and -28 ± 17, respectively (all errors on one sigma confidence level).



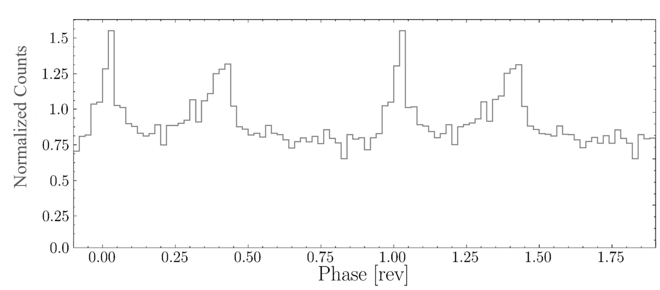
Results from the Bayesian analysis of the XL-Calibur Cyg X-1 data in three energy bands. Contour lines denote the 1 σ, 2 σ, and 3 σ credibility regions. The color scale denotes, for each location, the lowest-percentile credibility level into which that location could fall. (Image credit: Awaki et al. 2025a).

The PD is consistent with the PD found by *IXPE* in the 2-8 keV energy band. The most likely PA is consistent with the PA from *IXPE* and the PA of the VLBA radio jet. The absence of strong PD and PA variations from 2-8 keV to 15-60 keV suggest that the same mechanism operating in the same regime causes the observed polarization properties. Our current understanding is that either the Comptonization by hot electrons in the coronal plasma, or, the Comptonization by plasma ropes moving with relativistic velocities dominate the polarization signal. The *XL-Calibur* measurement is the most precise measurement to date of the hard X-ray polarization from this source, and helps fill in the gap between the soft X-ray polarization measured by *IXPE* and the gamma-ray polarization at higher > 100 keV energies (so far, *AstroSat* and *INTEGRAL*, in future COSI).



Compilation of Cyg X-1 polarization results from the X-ray band to the γ-ray band. The shaded regions show the 2–8 keV energy range of IXPE (left), the ∼19–64 keV energy range of XL-Calibur (middle), and the 200 keV–5 MeV energy range of the upcoming Compton Spectrometer and Imager (COSI). The upper limits for XL-Calibur (at the 99% level) and PoGO+ (at the 90% level) are given as well. The dashed and dotted line show archival model predictions. See Awaki et al. 2025a for references and details.

Refined Crab results: Following the publication of the Crab polarization in a [first *XL-Calibur* Crab paper], the team is now preparing a second paper that uses an enlarged data set for the pulsar phase resolved analysis. The refined analysis uses 30% more data that were initially not used as the events were not time tagged owing to an intermittent outage of the GPS receiver. The phase tags were derived by using the Crab's pulse profile as a stable, external reference signal. After determining the precise offset between the onboard detector clock and GPS timing, all observations could be aligned to a stable rotational ephemeris.



Phase folded light curve of the 20–60 keV X-rays detected with XL-Calibur from the Crab.

This produced high signal to noise pulse profiles in the 20 to 60 keV band and clearly defined main pulse, interpulse, bridge, and off-pulse intervals. A paper with the polarization results derived from the entire data set is in preparation.

First *XL-Calibur* **HEASARC release:** The science team released the *XL-Calibur* Cygnus X-1 and Crab event data with the timing, energy, and Stokes parameters for each event. The development of detector response files is still ongoing.

Upcoming flight opportunities: The *XL-Calibur* team is preparing the next launch of the experiment. Pending the availability of a flight opportunity from McMurdo (Antarctica), the telescope could be launched in December 2027 for a longer 8–60 day Long Duration Balloon (LDB) flight. The flight would allow the observations of 4–8 flaring X-ray sources. Prime source candidates include the accreting X-ray pulsar GX 301−2, the black hole X-ray binaries GX 339−4, H 1743−322 and MAXI J1535−571, and the blazar PKS 2155−304.

HEASARC

A. Ptak (NASA/GSFC)

HEASARC has been continuing to update its website with the new web design that embraces many of the principles of the NASA web modernization aimed to be user-friendly, accessible, and performant. The new design utilizes viewport resizing to view optimally on desktop or mobile platforms. These changes will be gradually applied to all of the website together with reorganization of the material. Your feedback is welcome.

HEASARC continues to sustain data ingest of CALET, INTEGRAL, IXPE, MAXI, NuSTAR, Swift, and the XRISM operating missions. INTEGRAL ended science operations in February 2025 and there is a plan for reprocessing data for the entire mission in the upcoming year that HESARC will ingest when completed. Chandra, eROSITA, FERMI, and XMM-Newton data are also mirrored at HEASARC. Mission proposal teams interested in having HEASARC be their data and/or software archive center should submit the form at HEASARC archive request.

HEASARC released HEASoft package version 6.36 on September 30, 2025. The HEASoft 6.36 release is driven by new and updated mission-specific data analysis software (XRISM, IXPE, MAXI, BurstCube, et al.) and other enhancements and fixes.

Starting with HEASoft version 6.35, HEASoft and XSpec are also distributed as conda packages. The packages are available from a custom channel hosted by the HEASARC and are built from the same source code available via the HEASoft standard download webpage. Installation guide and suggestions to how install HEASoft using conda are available from the HEASARC website. This distribution is experimental and feedback is welcome.

The search for a new HEASARC director position continues to be halted due to the current government hiring freeze. An interim director will likely be appointed by NASA Goddard astrophysics division leadership early next year.

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. PhysCOS moved to a new website this fall. While the old site is still available, it is no longer being updated and will soon redirect to the new site.

The PhysCOS Program Analysis Group (PhysPAG) includes everyone interested in the PhysCOS program via eight Science Interest Groups (SIGs); this probably means you! Many of the SIGs have activities ramping up, including the Cosmic Ray and Neutrino (CRN), Gamma Ray (GR), Gravitational Wave (GW), X-ray (XR), Inflation Probe (IP), Cosmic Structure (CoS), TDAMM, and Habitable World Observatory (HWO) SIGs– please see their articles in this newsletter for details. The PhysPAG provides a way for the PhysCOS community to regularly engage with the Program Office. We have 12 members in the PhysPAG Executive Committee (EC), providing insight and leadership, and steering the PhysCOS community in support of NASA's mission. The EC organizes meetings, collects and summarizes community inputs, and reports to the NASA Astrophysics Division Director. Several members of the current EC will be finishing their terms at the end of 2025; new members are in the process of selection at time of writing.

The Habitable World Observatory (HWO) SIG is the newest of the cross-PAG SIGs and two of the 6 co-chairs represent PhysCOS science, namely Fabio Pacucci and Richard Massey.

PhysCOS scientists attended and presented virtually at the 39th International Cosmic Ray Conference (ICRC), held on July 14–24, 2025, bringing our activities to a global audience of cosmic-ray scientists. The session titled "Physics of the Cosmos Program: Space-based Cosmic-ray, Neutrino, and Gamma-ray Science in the 2030s" featured an overview of PhysCOS activities, two contributed talks by Tsuguo Aramaki and Milena Crnogorcevic on cosmic-ray and gamma-ray science, respectively, and a panel discussion with members of academia.

PhysPAG EC chair David Pooley and X-ray SIG co-chair Breanna Binder staffing the PhysCOS table at the 22nd HEAD meeting. (Credit: Rodolfo Montez Jr.)

Members of the PhysPAG EC (see above image) supported the PhysCOS table at the 22nd HEAD meeting in place of the Program Office team who were unable to travel due to the government shutdown. At the table, we collected community inputs on development in analysis, theory and technology needed in the next few years to enable new science and missions in the next Astrophysics Decadal (Astro2030) and also the next steps needed to continue the implementation of Astro2020. Good feedback was received from the community.

PhysCOS is planning activities at upcoming conferences in 2026. At the 247th Meeting of the American Astronomical Society (AAS) (January 4-8, 2026, Phoenix, AZ), PhysCOS is supporting in-person meetings of the PhysPAG and of members of all three PAGs. This year we are conductiong a brainstorming session; splinter sessions for the X-Ray SIG, the AI/ML STIG, the ACROSS and Cosmic Pathfinders programs, and planning for Astro2030; as well as participating in the NASA booth in the Exhibition Hall. A full listing of our AAS activities can be found on our dedicated meeting webpage.

At the American Physical Society's (APS) Global Physics Summit (March 15-20, 2026, Denver CO), we will be supporting a Minisymposium covering PhysCOS and SIG and SAG activities and staffing a booth in the Exhibition Hall.

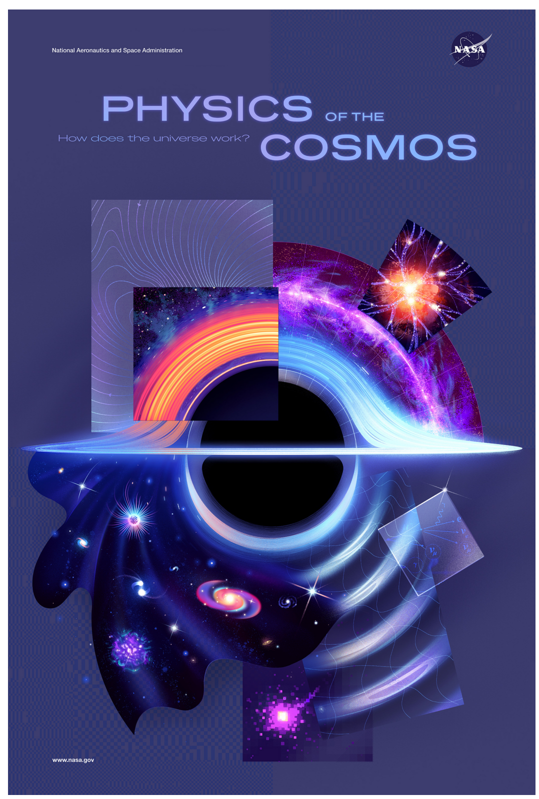
PhysCOS has also been working on ways to involve early-career scientists and provide them with insights about the fascinating work done in the Physics of the Cosmos Program, including exposing them to missions, opportunities, funding, and available tools for research. As part of this effort, we held our Second Annual Early Career Workshop, which took place virtually on September 23-25, 2025, and focused on NASA Science, Missions and Careers. There were 277 registrants in total, with between 115 and 143 attendees connected daily. During the Science and Missions days, 8 presentations featured results from early career scientists, chosen from 40 submitted abstracts.

Five PhysCOS Science Analysis Groups (SAGs) are currently active and working on their findings: the Future Innovations in Gamma Rays (FIG) (focusing on identifying future science drivers, necessary capabilities, and priorities for the future of gamma-ray astronomy); three new X-ray SAGs focusing on the future of X-ray astronomy (more details about these in the X-ray (XR) SIG article) and a newly formed CMB SAG to discuss significant recent developments compelling a critical re-evaluation of the role of a CMB probe.

The PhysCOS program office, together with the artist Jason Solo and the PhysPAG EC, have developed a new graphic (see image below) to artistically evoke the great questions embedded in our theme "How does the universe work?". The graphic will be printed on a poster and distributed at upcoming conferences.

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 lists, where we regularly highlight items of interest to the PhysCOS community, including workshop announcements and funding or employment/internship opportunities.



New PhysCOS poster image, featuring the full gamut of PhysCOS science. (Image Credit: NASA/Jason Solo).

Time-Domain and Multimessenger Astronomy Science Interest Group

REBEKAH HOUNSELL (UMBC/NASA GSFC), BRAD CENKO (NASA/GSFC), BRIAN GREFENSTETTE (CALTECH), & CHRISTOS PANAGIOTOU (MIT)

The Time-Domain And MultiMessenger (TDAMM) Science Interest Group (SIG) is a partnership across the NASA Astrophysics programs, being led by Physics of the Cosmos with involvement from Cosmic Origins and Exoplanet Exploration. The goals of the SIG include making the community aware of NASA missions and initiatives of relevance, and soliciting input from the community back to NASA for scientific, technical, or programmatic priorities in the TDAMM umbrella.

Recent virtual meeting held by the TDAMM SIG include:

- May 21st: Exploring the Changing Sky with the Vera C. Rubin Observatory LSST. Speaker Michael Wood-Vasey
- August 12th 2025: Swift and TDAMM: New Tricks for the Old Dog. Speaker Prof. Jamie Kennea, Penn State University
- September 15th: Transient Science with Euclid — Early Results and Prospects. Speaker Chris Duffy

The fourth TDAMM workshop was held October 27th-30th 2025 in Huntsville, Alabama and focused on the topic of advancing community-driven observation plans for rapid follow-up of explosive transients. The workshop was organized by NASA's new Astrophysics Cross-Observatory Science Support (ACROSS) initiative. A white paper on the topic(s) of the meeting are expect mid-late 2026.

To learn more about the TDAMM SIG and be notified about upcoming talks please visit our webpage and get involved!

News from ACROSS

BRIAN HUMENSKY (NASA, GSFC))

The Astrophysics Cross-Observatory Science Support (ACROSS) initiative represents part of NASA's response to the Astro2020 Decadal Survey's identification of Time-Domain and Multi-Messenger Astrophysics (TDAMM) as a top priority for the 2020s. This cross-center collaboration between Marshall Space Flight Center (MSFC), Goddard Space Flight Center (GSFC), and Penn State University addresses coordination challenges that impact the capability for rapid response to new astrophysical events across NASA's fleet (and ground- and space-based observatories globally). ACROSS provides the infrastructure needed to implement a "whole-of-fleet" approach to TDAMM science, ensuring smaller missions like BurstCube achieve maximum impact alongside flagship observatories.

ACROSS is working to build out four key capability areas. The TDAMM Web Portal, which may be live by the time you are reading this, will serve as a central hub hosting tools and information for coordinating multi-observatory campaigns. **Science Feasibility Tools** provide standardized data interfaces for instruments, including observing plans and target visibility calculations, with value-added features like coincidental event detection for wide-field instruments. These tools are available via API, a user-friendly Python client library, and interfaces hosted on the web portal. **Modern ToO Resources**, to be developed in the coming year, will offer a modernized approach to submitting ToO proposals through an API for smaller missions (or any mission that would like to receive ToOs through this system) or web app interface. These capabilities build upon ACROSS's newly deployed API server providing multi-mission schedule data since October 2025, with plans to support IVOA endpoints and integrate additional ground-based and international facilities. All of these tools will be available as open-source Python tools. Finally, **Community Engagement** organizes workshops (including the annual TDAMM Workshop series), develops funding opportunities, and maintains active participation in community-led initiatives.

The 4th TDAMM Workshop in Huntsville, Alabama (October 27-30, 2025) brought together 100+ participants who developed eight science cases for rare, high-importance explosive transient events, defining requirements for cross-observatory follow-up capabilities. The Scientific Organizing Committee is drafting a white paper for community review in February 2026, with final publication in April 2026.

The high-energy astrophysics community is invited to attend the ACROSS special session at the 247th AAS meeting on Wednesday, January 7, from 10:00-11:30am in room 226B for live demonstrations and community discussion about these new coordination tools.

The X-ray Science Interest Group

DAVID POOLEY (TRINITY U., EUREKA SCI.), CHIEN-TING CHEN (USRA, NASA MSFC), BREANNA BINDER (CAL POLY POMONA), STEVEN EHLERT (MSFC), & FABIO PACUCCI (CFA)

The X-ray Science Interest Group (XR SIG) provides a platform for discussion between NASA's Physics of the Cosmos (PhysCOS) Program and the X-ray Science community. As part of NASA's web redesign, we have a new XR SIG site within the PhysCOS pages at science.nasa.gov.

Despite the government shutdown, the XR SIG leadership has been busy with preparations to help our community get ready for the next astrophysics decadal survey:

- We have begun three Science Analysis Groups (SAGs) to explore the science enabled by flagship-missions with different capabilities. These are described below in more detail, and we welcome broad community participation in all of them.

- We organized a session at the HEAD meeting in St. Louis to introduce these SAGs to the community. Fabio Pacucci, Herman Marshall, and Daniel Stern each gave an informative and compelling presentation, all of which can be found here.

- We are running an online Future of X-ray Astrophysics seminar to bring the community up to speed on the latest in technology and scientific developments. The presentation slides and videos are archived under the News & Events section of our new website.

The High Angular Resolution X-ray (Hi-ReX) Imager SAG will assess the scientific potential of a future flagship-class or probe-class mission with mas to μas imaging resolution, identifying key science drivers, performance requirements, and initial technical considerations, while remaining focused on science. This effort will build on previous and current conceptual studies and recent progress in optics and lens designs. The Hi-ReX SAG is being co-chaired by Kim Weaver (GSFC), Mark Schattenburg (MIT), Herman Marshall (MIT), and Breanna Binder (Cal Poly Pomona). The first kickoff meeting of the Hi-ReX SAG will be held on December 17, 2025 at 12 pm EST (9am PST). To subscribe to the Hi-ReX SAG mailing list, please send an email to Hi-ReX-SAG-join@lists.nasa.gov with "Join" as the subject line of the email.

The Lynx 2030 SAG will revisit the Lynx science portfolio and reference design model in the context of the current astronomy landscape. The Lynx 2030 SAG is chaired by Steven Ehlert (MSFC) and Fabio Pacucci (SAO CfA). There are currently six working groups being formed for this SAG, and we invite the entire XRSIG community to join in the efforts to help define the science case for a successor mission to Lynx. To subscribe to the Lynx 2030 SAG mailing list, please send an email to Lynx2030-SAG-join@lists.nasa.gov with "Join" as the subject line of the email.

The Broad Band X-ray Observatory (BBX) SAG's goal is to help shape future large-scale NASA X-ray missions by outlining the key scientific drivers and technological considerations for broad-band focusing X-ray astrophysics. The SAG is co-chaired by Chien-Ting Chen (USRA/MSFC), Kristin Madsen (GSFC), and Daniel Stern (JPL). The work will involve a small number of teleconferences and collaborative discussions, with individual writing contributions expected to be modest. Building on the substantial efforts invested in recent and ongoing mission concepts, as well as technological developments in areas such as mirrors and detectors, we anticipate a manageable and productive activity that also welcomes new ideas and directions. A kickoff meeting in December/January will be announced through the BBX mailing list. To subscribe, please send an email to to BBX-SAG-join@lists.nasa.gov with "Join" as the subject line of the email.

We also encourage the entire X-ray community to join the XR SIG mailing list to be informed of the progress of the Science Analysis Group and of future opportunities to present at XR SIG sessions at AAS or HEAD meetings. 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

Manel Errando (WashU at St. Louis), Cori Fletcher (MSFC/USRA), Sylvain Guiriec (GWU), & Jeremy S. Perkins (GSFC)

The Gamma-Ray Science Interest Group (GRSIG) organized two well-attended sessions at the HEAD Meeting in St. Louis in October 12-16, 2025. A session on *Gamma-ray Astrophysics in the 2030's and Beyond: Opportunities, Theory, Technology, and Strategy*, provided a forum for members of the Future Innovations in Gamma Rays SAG (FIG SAG) to present and discuss their findings. Their report, which will be released to the community shortly, outlines key scientific priorities and capability needs for the next generation of gamma-ray missions. The session highlighted how advances in instrumentation, data analysis, and theoretical modeling converge on a unified strategy for exploring compact-object physics, nuclear-line astrophysics, dark-matter signatures, and the time-domain universe.

A second session on *Balloon and Sounding Rocket Technology Developments: A Platform for Early-Career Instrumentation Scientists* showcased active suborbital programs that serve both as technology pathfinders and as training grounds for graduate students and postdoctoral researchers. Presentations spanned a broad array of instruments, current missions and prototypes, including the hard X-ray polarimeter *XL-Calibur*; the *SuperHERO* mission to test replicated hard X-ray optics; the first tests of transition edge sensors onboard the Dilution Refrigerator–Transition Edge Sensor (*DR-TES*) payload; or the *GRAMS* detector designed MeV gamma-ray astrophysics and antimatter searches. Additional talks covered the use of the *AstroPix* silicon-pixel detector and its application to instruments such as *A-STEP* and *ComPair*; the potential for real-time gamma-ray burst localization to be flown with the *ADAPT* balloon demostrator; and the student-led Background and Transient Observer (*BTO*) to be launched aboard *COSI*. Collectively, these presentations demonstrated the scientific breadth, rapid development cycles, and professional training value of suborbital platforms, underscoring their essential role in maturing technologies that will shape future space-based gamma-ray observatories.

The Cosmic Ray and Neutrino Science Interest Group

TSUGUO ARAMAKI (NORTHEASTERN), PRIYARSHINI GHOSH (GSFC), ATHINA MELI (NC A&T STATE, & STEPHANIE WISSEL (PENN STATE)

The Cosmic Ray and Neutrino Science Interest Group (CRNSIG) hosted a webinar on Galactic Searches for Cosmic-Ray Nuclei on November 5. We invited five speakers on the recent NASA galactic cosmic-ray missions and theories/modeling, while also discussing science opportunities and technological gaps. Present and upcoming missions are driven by open questions in dark matter signatures, diffuse emissions, galactic phenomena, nucleosynthesis and cosmic-ray interactions, and interstellar gas chemistry. Urgent needs identified were: (1) missions that provide observational data on the galactic abundance of heavy elements, like TIGERISS expected to be installed on the ISS in 2027, and (2) a pressing need to measure nuclear cross-sections that are imperative to translating these mission-observational data to meaningful understanding of our galaxy.

The next webinar is being planned on the connections between cosmic ray and neutrino missions and time-domain and multimessenger astrophysics (TDAMM). We welcome contributions to the next webinar and invite members to join CRNSIG. Please contact the CRNSIG Co-Chairs for any comments or contributions.

The CRNSIG also eagerly anticipates the launch of two missions related to cosmic rays and neutrinos: GAPS and PUEO during the 2025-2026 Antarctic long-duration balloon campaign.

Cosmic Structure Science Interest Group

REBEKAH HOUNSELL (UMBC/NASA GSFC) & JOHANNES U. LANGE (AMERICAN UNIVERSITY)

The Cosmic Structure Science Interest Group serves communities interested in utilizing measures of cosmic structure based on 3-dimensional spectroscopic and photometric surveys of galaxies, galaxy clusters, supernovae, and gravitational lensing. Science drivers for the SIG include understanding the nature of dark energy, dark matter, neutrinos, and tests of inflation, as well as astrophysical galaxy evolution, amongst others.

Recent virtual meetings held by the COS SIG include:

- May 12th: DESI DR2: Measurements of Baryon Acoustic Oscillations and Cosmological Constraints - Uendert Andrade (University of Michigan)
- June 2nd: Cosmic Shear Cosmology with the Completed Kilo-Degree Survey - Angus Wright from the KiDS collaboration
- August 4th: Prospects for Solving Baryonic Feedback in Weak Lensing using FRBs — Calvin Leung (Berkeley)

To learn more about the COS SIG and be notified about upcoming talks please visit our webpage and get involved!

HEAPoetry Corner

CURATED BY ADI FOORD (UMBC)

My God, it's Full of Stars (Excerpt)

....
Perhaps the great error is believing we're alone,
That the others have come and gone—a momentary blip—
When all along, space might be choc-full of traffic,
Bursting at the seams with energy we neither feel
Nor see, flush against us, living, dying, deciding,
Setting solid feet down on planets everywhere,
Bowing to the great stars that command, pitching stones
At whatever are their moons. They live wondering
If they are the only ones, knowing only the wish to know,
And the great black distance they—we—flicker in.
....

— Tracy Smith