The High Energy Astrophysics Division Newsletter

In this Newsletter:

From the Chair

CHRIS REYNOLDS (UMD)

As 2016 draws to a close, I have tremendous optimism about the future of high-energy astrophysics in the USA. After the tragic loss of Astro-H/Hitomi in March this year, we can celebrate the news that the Japan Aerospace Exploration Agency (JAXA) and NASA are discussing a replacement mission that would recover the high-spectral resolution science that was lost, launching as early as 2021. And we have exciting missions on the verge of being launched, including the Neutron star Interior Composition Explorer (*NICER*, early 2017) and Spectrum-Röntgen-Gamma (SRG, late 2017).

Looking further into the future, we have two X-ray polarimetry missions under review, the Polarimeter for Relativistic Astrophysical X-ray Sources (PRAXyS), and the Imaging X-ray Polarimeter Explorer (IXPE), which would open this new window on the X-ray Universe. We have a slew of innovative high-energy probe-class concepts recently submitted to NASA. And, finally, the X-ray Surveyor and L3 Gravitational Wave Mission Science and Technology Definition Teams continue to hone these strategic-class mission concepts for consideration by the next Decadal Survey. To all of you who are spending so much of your precious time pushing ahead on these future projects – the best of luck and may all of your hard work bear fruit!

Back on Earth, we are looking forward to a slew of HEAD events at the Grapevine-Texas AAS meeting in January. In addition to our special sessions on "Astronomy Across the Gravitational Spectrum" and "The Physics of the Perseus Cluster, and Other Highlights, From Hitomi", we have the Rossi Prize lecture by Prof. Niel Brandt and splinter sessions on both X-ray Surveyor and *Athena*. Excitement is also building for the August 2017 HEAD meeting in Sun Valley Idaho, which is in the path of totality for 2017 total solar eclipse. Rooms in the hotel are now available for booking, registration will open in the early Spring, and our call for Special Sessions will be issued very shortly.

Of course, this Chair's column would not be complete without acknowledging the uncertainty and fear that many of us feel after this polarizing presidential election campaign and the incidents of harassment which have been increasingly reported since election day. Echoing the statement by AAS President Christine Jones, we must use moments like this to reaffirm our core values as citizens and as scientists: to treat each and every member of our Society, and society in general, with respect and dignity, and to commit ourselves to an open and inclusive community within the Division and without.

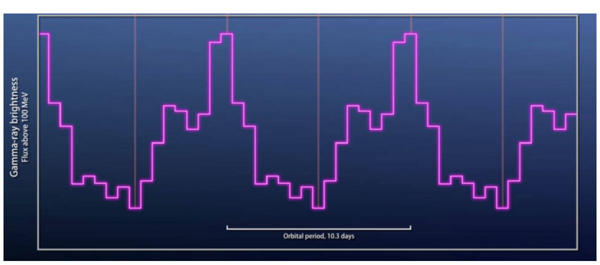
HEAD in the News

MEGAN WATZKE (CXC)

Press releases are an important means to highlight the scientific contributions of high-energy astrophysics missions and to show the taxpayer return on scientific investment. Since last spring, HEAD missions have enabled discoveries on everything from Pluto to pulsars, from black holes to dark matter, and, of course, the exciting developments in gravitational waves. The list below is just a sample of the results that were publicized in the last six months alone. These releases have generated hundreds of articles in outlets around the globe, reaching audiences of millions of people.

- April 28, 2016 NASA's Fermi Telescope Helps Link Cosmic Neutrino to Blazar Blast
- April 28, 2016 "Russian Doll" Galaxy Clusters Reveal Information About Dark Energy
- June 15, 2016 *LIGO* Does it Again: A Second Robust Binary Black Hole Coalescence Observed
- June 22, 2016 X-ray echoes of a Shredded Star Provide Close-up of "Killer" Black Hole
- July 27, 2016 Astronomers Gain New Insight into Magnetic Field of Sun and its Kin
- July 28, 2016 Chorus of Black Holes Sings in X-rays
- August 12, 2016 NASA's Fermi Mission Expands its Search for Dark Matter
- August 29, 2016 XMM-Newton Reveals the Milky Way's Explosive Past
- September 14, 2016 X-ray Detection Sheds New Light on Pluto
- September 16, 2016 NASA's Fermi Finds Record-breaking Binary in Galaxy Next Door
- October 27, 2016 NASA Missions Harvest a Passel of "Pumpkin" Stars

As always, weekly highlights of high-energy astrophysics science are featured at the High Energy Astrophysics Picture of the Week. Please e-mail Mike Corcoran if you have a result worth highlighting.

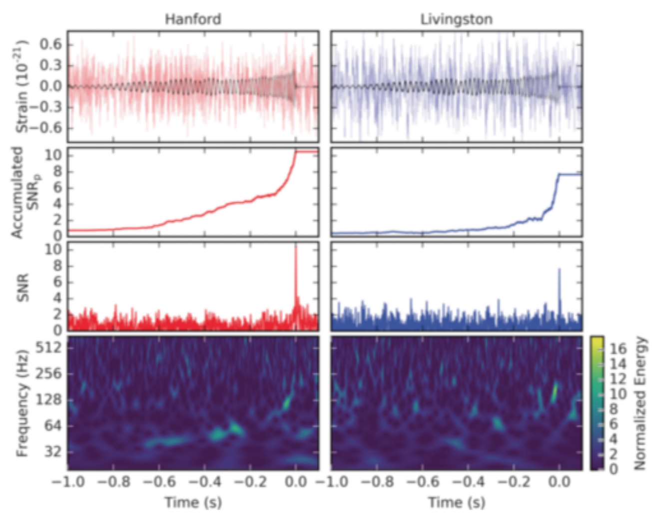


Variation with time of gamma-ray flux from LMC P3, phased with a 10.3 day period. This is the first gamma-ray binary system identified outside the Milky Way. Credit: NASA's Goddard Space Flight Center; R. Corbet.

LIGO

Fred Raab (Caltech), David Shoemaker (MIT)

We reported in the last newsletter that *LIGO* had made one confirmed observation of a gravitational wave signal from a binary black hole system. With the completion of the run in January 2016, and analysis during and after the run, *LIGO* confirmed a second binary black hole (BBH) observation, GW151226 (the "Boxing Day event"), while a third BBH trigger still has a 2% probability of being an instrumental artifact. Data analysis from the first 'O1' observing run continues for a range of possible sources of gravitational waves. In parallel, commissioning on the *LIGO* instruments has continued, and they are nearing readiness for the start of the second 'O2' observing run with somewhat higher sensitivity. O2 will start in late 2016 and have a duration of roughly 6 months.



LIGO Hanford (left) and Livingston (right) observations of GW151226. First (top) row: Observed, filtered strain from each detector with the best-match GW template in black; Second row: Accumulated peak signal to noise ratio. Third row: Signal to noise ratio time series where the peak shows the merger time of the best match template. Fourth row: Time-frequency representation of the strain data. Adapted from Abbott et al., Phys. Rev. Lett. 116, 241103.

The Advanced Virgo detector is planning on joining *LIGO* for the second half of the O2 run. The sensitivity of Virgo for this run is not expected to be at the level of the *LIGO* instruments, as its commissioning will have just started, but the hope is that *LIGO* and Virgo will jointly observe signals allowing better sky localization to aid in multi-messenger astrophysics. Memoranda of Understanding have been established with some 75 electromagnetic observational partners, and in O1 a number of alerts were distributed, although with varying (and sometimes long) latency as the *LIGO* team worked out the challenges of this new program. For O2, the *LIGO*-Virgo Collaborations will continue to send alerts while striving to shorten the latency and with the improved source information from Virgo.

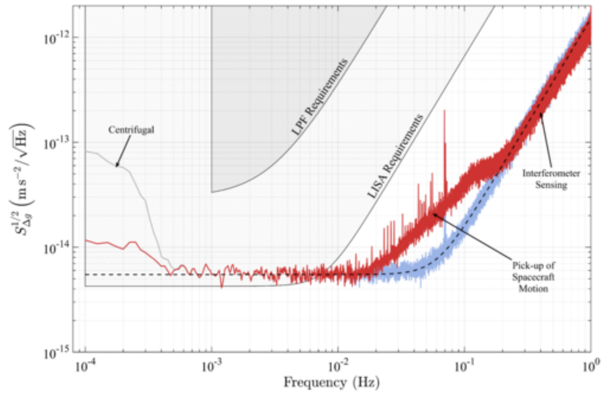
The *LIGO*-India train is now rolling, and picking up speed. The MoU to establish *LIGO*-India was signed at the end of March 2016 by the Director of the U.S. National Science Foundation and the Secretary of the Department of Atomic Energy of India. India will build and operate an observatory facility in India to house the third Advanced

LIGO detector, which is currently in storage at *LIGO* Hanford Observatory. The three *LIGO* detectors in Hanford, India and Louisiana will be operated in unison as the *LIGO* Global Network. Four institutes are involved building *LIGO*-India: the DAE Division of Construction Services and Estate Management has responsibility for the civil infrastructure, the Institute for Plasma Research has responsibility for the vacuum system, the Inter-University Center for Astronomy and Astrophysics has responsibility for site selection, human infrastructure development and science, and the Raja Ramanna Center for Advanced Technology has responsibility for the detector logistics, installation, integration, testing and commissioning. The *LIGO* Laboratory in the U.S. is providing all drawings and other documentation on both the *LIGO* facilities and detectors as well as advice, and formal review and concurrence as the project proceeds. Site selection has converged with selection of a preferred site and a back-up site, and site acquisition work is underway. The conceptual design of site infrastructure and buildings is underway, and we are preparing to review the documentation, and planning for vacuum system construction.

LISA

James Ira Thorpe (GSFC), Guido Mueller (UFL)

The space-based gravitational wave community was thrilled with the results from *LISA* Pathfinder, which published its preliminary findings in the cover article of Physical Review Letters on June 7th. Not only did the measured acceleration noise performance exceed expectations set for *LISA* Pathfinder, but it approached the targets set for *LISA* itself – greatly reducing the level of technical risk for a future *LISA*-like mission. Shortly after those results were published, NASA's Disturbance Reduction System took over control of the Pathfinder spacecraft and began a several-month stretch of operations designed to characterize the performance of the colloidal microNewton thrusters and exercise the dynamic control system that carefully guides the Pathfinder spacecraft and its two freely-falling gold-platinum cubes in their delicate formation-flying dance. Preliminary results presented at the 11th *LISA* Symposium held in Zürich in early September suggest that both the thrusters and control system are performing well. Both the European and American teams will be involved in an extended mission for *LISA* Pathfinder which will occur through the Spring of 2017 and include additional experiments to characterize the instrument and build important experience for the development and operations of *LISA*. Beyond the technical achievements, Pathfinder has provided an important opportunity for an international team of scientists, engineers, managers, and support staff to collaborate on a precision-measurement spacecraft. The lessons learned and relationships built will also prove extremely valuable for future collaborations on *LISA*.



Red: Amplitude Spectral Density of Δg , $S_{\Delta g}^{1/2}(f)$, measured for 6.5 days starting 127 days after launch, after correction for the centrifugal force (visible at the lowest frequencies). Light blue: ASD after correction for the pickup of spacecraft motion by the interferometer (IFO). Shaded areas: LISA and LISA Pathfinder requirements. From Armano et al., 2016, PRL 116, 231101.

In the US, the Midterm Assessment of the National Academies was released and *LISA* and the future L3 mission were addressed multiple times. Especially noteworthy is recommendation 4-4, that NASA should restore support this decade for gravitational wave research that enables the U.S. community to be a strong technical and scientific partner in the European Space Agency (ESA)-led L3 mission, consistent with the Laser Interferometer Space Antenna's high priority in the 2010 report New Worlds, New Horizons in Astronomy and Astrophysics (NWNH). One goal of U.S. participation should be the restoration of the full scientific capability of the mission as envisioned by NWNH.

The Eleventh International *LISA* Symposium took place in early September in Zürich. It was jointly organized by ETH Zürich and University of Zürich and it is probably fair to say that the mood at the symposium was elevated. The Eleventh Symposium had many highlights, including the presentation of the first direct detections of gravitational waves by Advanced LIGO and several presentations about the fantastic results of the *LISA* Pathfinder mission. Additional highlights included presentations by ESA's Director of Science, Alvaro Giménez, NASA's Director of the Astrophysics Division, Paul Hertz, and the Head of ESA's Advanced Studies and Technology Preparation Division, Frederic Safa. All showed strong support for L3, the future space-based gravitational wave observatory.

Another highlight for *LISA* came in the form of ESA's call for mission concepts for the L3 mission which was released on October 25th [4]. The European *eLISA* consortium with the support of the US L3-Study Team is planning to respond with a detailed mission proposal by mid-January. This proposal, and other potential proposals will then be competed for future industrial studies, with selection in May 2017. The current schedule foresees a launch in the late 2033/early 2034 timeframe.

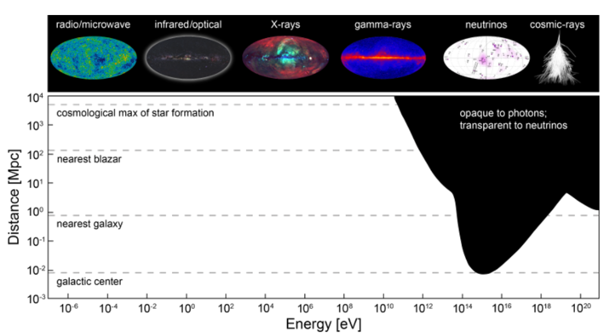
IceCube

Jakob van Santen (DESY)

Nearly 6 years after its completion, IceCube continues to operate nominally. The reliability of the detector exceeds expectations, with only 32 of the 5484 deployed Digital Optical Modules (DOMs) having failed since commissioning. At the current rate of failure, we expect fewer than 150 DOMs to fail before 2030, leaving more than 97% of the detector active. In April, the NSF renewed UW-Madison's maintenance and operations contract, ensuring that data-taking will continue at least through 2021.

In the 3 years since we presented the first evidence for a high-energy astrophysical neutrino flux, we have refined our measurements of its properties. We observe similar neutrino fluxes in both the contained-event channel, which is sensitive primarily to neutrinos of all flavors from the Southern sky, and in up-going muons, which is sensitive exclusively to muon neutrinos from the Northern sky. Furthermore, we have combined measurements in these channels to yield constraints on the flavor composition of the astrophysical neutrinos we observe.

At the same time we have continued to search for the sources of these neutrinos. Direct searches for single point sources of neutrinos have placed upper limits on the flux from single sources, and imply that the overall neutrino flux we observe is produced jointly by a large number of sources. In addition, we have constrained the contribution of specific source classes to the neutrino flux by searching for excesses from sources observed by gamma-ray telescopes like *Fermi*. GRBs, for example, can produce no more than 1% of the flux, and blazars can be responsible for no more than 17%. Given our current constraints on the strength of the sources, there is a distinct possibility that the underlying sources will remain out of the reach of IceCube for decades to come. To push deeper, we need to collect significantly more high-energy neutrinos per year than we currently do.



At PeV energies, the universe is almost entirely opaque to photons, making neutrinos the only messengers that can travel long distances in straight lines to bring us information about the most active parts of the non-thermal universe. We have observed the same energy density in neutrinos as in photons, pointing to similarly rich astronomy in this presently hidden part of the spectrum. Credit: Marek Kowalski, IceCube/DESY

To that end, design studies are underway for IceCube-Gen2, a multi-km^3 neutrino observatory at the South Pole. The new detector will augment the existing 86-string IceCube detector with 120 new strings, instrumenting a total volume of 7–10 km^3. Where IceCube observes roughly 1 neutrino with more than 1 PeV of energy per year, Gen2 would observe 10. The increased statistical power will allow us to measure the energy spectrum of the astrophysical neutrinos up to nearly 100 PeV, providing overlap with future radio detectors aimed at cosmogenic neutrinos. Moreover, we will be able to measure the fraction of tau neutrinos appearing through oscillation over cosmic baselines, providing constraints on new physics at energy scales well beyond those achievable at terrestrial accelerators. These measurements will be combined with a broad multi-messenger observation program to discover the sources of the astrophysical neutrinos. With the larger effective area and increased angular resolution that we will achieve with improved sensor technology, we will able to discover high-energy neutrino production even in relatively numerous sources like Active Galactic Nuclei (AGN).

In the immediate future, we are planning a small demonstrator array that, in addition to its primary mission of precision oscillation physics with GeV atmospheric neutrinos, will provide improved calibration for the existing IceCube detector, and serve as a testbed for the improved sensors forseen for the full Gen2 array. With Gen2, we have an opportunity to move from discovery to observational astronomy with an effort that is similar in scope to the initial IceCube.

The Chandra X-ray Observatory

Roger Brissenden (SAO) and Martin C. Weisskopf (MSFC)

The *Chandra* X-ray Observatory has carried out more than 17 years of highly successful and productive science operations. *Chandra* is unique in its capability for producing the sub-arcsecond X-ray images that are essential to accomplish the science goals of many key X-ray and multi-wavelength investigations in current astrophysical research. The *Chandra* Project is looking forward to many more years of scientific productivity. Science data processing, archiving, and distribution proceed smoothly, with average time from observation to data delivery to observers remaining at about a day. NASA has announced its decision to continue the *Chandra* program, potentially through 2030, by extending the *Chandra* X-ray Center (CXC) contract with the Smithsonian Astrophysical Observatory.

Images from the Chandra Data Archive. Top row, left to right: Westerlund 2; 3C31; PSR J1509-5850; Bottom row, left to right: CTB37A; Abell 665; the "Toothbrush" cluster. Credit: NASA/CXC/SAO

The Observatory continues to operate extremely well overall but with a number of incremental changes in performance, due primarily to the gradual accumulation of molecular contamination on the UV filter that protects the ACIS detector, and to progressive degradation of the spacecraft's thermal control surfaces. Condensation on the filter reduces the sensitivity of ACIS to low-energy X-rays (but does not affect the HRC). The *Chandra* Project Science group at NASA/MSFC, together with the CXC, continues to consider the possibility of baking out the ACIS filter to remove condensed contamination. The decline in insulation effectiveness results in thermal constraints that require extra effort in scheduling observations and the use of special strategies to ensure continued safe operation in the evolving thermal environment, but has not significantly affected *Chandra*'s observing efficiency.

The combined effects of accumulated radiation damage and increasing temperature on *Chandra*'s aspect camera CCDs have begun to reduce the camera's ability to detect faint stars. Left unchecked, this trend would present difficulty in acquiring and tracking guide stars, which could decrease mission efficiency. Several mitigation strategies have been implemented, and further options are under investigation, including a program of testing to assess the feasibility of annealing the CCD detectors.

As part of NASA's biennial Senior Review of operating missions, *Chandra* X-ray Center and Marshall Space Flight Center program staff submitted the *Chandra* Senior Review proposal in January 2016, and the NASA review committee conducted a site visit at the CXC in March. Following release of the committee's report in June, which praised *Chandra*'s scientific productivity and the program's stewardship of the observatory, the program submitted to NASA Headquarters a plan for responding to the committee's findings.

The peer review of Cycle 18 proposals was held in June 2016 and approved 168 proposals (including observation, archive and theory) of 547 proposals submitted by scientists from 25 countries.

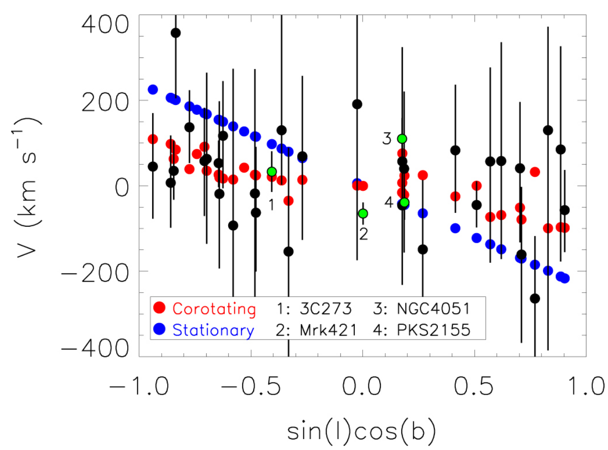
In August, the CXC held a workshop, "*Chandra* Science for the Next Decade", to provide an opportunity for the scientific community to help guide future Chandra scientific programs. The annual Einstein Fellowship Symposium, at which current Einstein Fellows present their recent research results, was held in Cambridge, MA on 18-19 October 2016.

The *Chandra* Press Office has been active in issuing image releases, science press releases and other communications of *Chandra* research results (for examples, see Megan Watzke's "HEAD in the News" article above). More information about the Chandra Observatory can be found at the Chandra X-ray Center.

XMM-Newton

Lynn Valencic (JHU & GSFC)

The 16th Call for Proposals for *XMM–Newton* closed October 7, 2016. There were 442 proposals submitted, 67 of which were for Large Programs and 82 of which were for joint programs with *Swift*, *VLT*, *Chandra*, or *NuSTAR*. Taking both principal and co-investigators into account, about 1500 scientists were involved in the response to the Call. The oversubscription rate was 6.3. Successful submissions will be announced in late December. Funding will be available for A/B-ranked proposals with US PIs; Phase II proposal submission for approved proposals will run from January 10 – February 3, 2017. Approved observations are planned to be performed starting in May 2017.



Centroid velocities of the OVII absorption line measured by the XMM/RGS to a selection of bright AGN and Local Group X-ray binaries along various lines of sight as a function of Galactic longitude and latitude. The OVII absorption lines, which primarily originate in the hot halo of the Milky Way, rule out a stationary model for the Milky Way's hot halo at better than 98% confidence, with a best fit rotational velocity of $v_\phi = 183 \pm 41$ *km* s^{-1}*. From Hodges-Kluck, Miller & Bregman, 2016, ApJ, 822, 1.*

Presentations from the *XMM–Newton* Science Operations Centre (SOC)'s workshop on "*XMM–Newton*: The

Next Decade" are now available online. The refereed proceedings will be published in Astronomische Nachrichten. The agenda, minutes, and presentations from the June 2016 Users Group Meeting are now available online as well.

INTEGRAL

Erik Kuulkers (ESA/ESTEC) and Steve Sturner (CRESST/UMBC & GSFC)

Last year, *INTEGRAL* operations were approved through December 31, 2018, subject to a mid-term review and confirmation this year. Through the course of 2016, *INTEGRAL*'s confirmation (2017/2018) and extension (2019/2020) science case and associated appendix were finalized. The science case was presented at the joint 163rd meeting of the Astronomy Working Group (AWG) and 27th meeting of the Solar System and Exploration Working Group (SSEWG) on October 13. The outcome of these meetings has been passed on to the Space Science Advisory Committee (SSAC). The SSAC has provided their recommendation to the Science Program Committee (SPC), who will decide on the confirmation and extension of *INTEGRAL*'s operations.

The three-year terms of Tony Bird, Lorraine Hanlon and Dieter Hartmann as external scientists on the *INTEGRAL* Users' Group (IUG) expired on 1 July. The entire *INTEGRAL* community thanks them for their help and effort in their three years of service. They are replaced by Diego Götz, Angela Malizia and Diego Torres. The current PI of the ISDC Data Centre for Astrophysics, Thierry Courvoisier, has retired; Carlo Ferrigno (*INTEGRAL* operations lead at ISDC) is now responsible for all contractual relations regarding *INTEGRAL*. The next IUG meeting (#19) will take place after the SPC meeting in February, 2017.

The AO-14 Target Allocation Committee (TAC) meeting took place May 17–19 at ESA/ESAC, Spain. 50 proposels were selected, including 21 Target-of-Opportunity (ToO) follow-up observations, and 3 gamma-ray burst (GRB) proposals. Preparations for the next call for proposals (AO-15) have started. The call will be open from 20 February to March 31, 2017. The AO-15 TAC meeting is set for May 15–17, 2017.

The spacecraft, payload and ground segment have been generally performing nominally. JEM-X2 experienced problems from May 27 – June 3, and most of the data acquired during that time were lost. On October 4, JEM-X2 was switched off due to an error in instrument setup. As a consequence neither JEM-X2 science packets nor housekeeping packets were downlinked, nor did the instrument react to signals sent to the instrument. It was therefore powered off, and started up again. The recovery was nominal.

The 27th SPI annealing took place from July 23 to August 7. The resulting energy resolution recovery was satisfactory, but not perfect: the energy resolution at 198 keV after the annealing period was 2.1 keV. This can be explained by an increase in the background due to the decrease in Solar activity. During the SPI annealing period, observations not depending on SPI were performed.

Scientific observations of the AO-13 cycle have been performed mostly as planned. Several coordinated multiwavelength observations (involving combinations of *XMM–Newton*, *NuSTAR*, *Swift*, *Chandra*, and ground based observatories as well) were performed on Cyg X-1, 3C273, and other sources. *INTEGRAL* performed an out-of-TAC ToO observation to search for high-energy emission associated with the IceCube neutrino event HESE 128340 58537957. No significant high-energy transients coincident with the neutrino event were found. Since our last report, five Gamma-Ray Bursts (GRB 160629A, GRB 160521A, GRB 161010A, GRB 161020A, GRB 161023A) were detected in the field-of-view (FOV) of the high-energy instruments.

The image depicts Van Gogh's view from his asylum window in Southern France, had INTEGRAL been aloft at this time (and in an especially low-earth orbit). Credits: Arash Bodaghee (GCSU) and Vincent van Gogh.

INTEGRAL could not confirm the Fermi/GBM report (Connaughton *et al.* ApJ 826, L6) of a weak (2.9σ) transient 0.4 s after the gravitational wave event GW150914 detected by *LIGO*. A joint *Fermi/INTEGRAL* collaboration has been initiated to investigate the issue, and to come to a common cross-calibration, useful also for future events. The localization probability of the weak gravitational wave event LVT151012 peaked in the field-of-view of the *INTEGRAL* instruments. No significant high-energy transient associated with LVT151012 was found. The *INTEGRAL* team is considering ways of detecting high-energy electro-magnetic counterparts to Gravitational Wave events and ultra-high energy neutrino events with *INTEGRAL*, and is refining strategies for (quick) follow-up observations. A Memorandum of Understanding was signed with the IceCube collaboration to help further this effort.

Final delivery to Guest Observers of the new *INTEGRAL* data analysis software, OSA 11, has been delayed, and will now probably take place in early January. The first version of ESA's new science-driven discovery portal, ESASky, was released on July 15. ESASky provides full access to the entire sky as observed with space astronomy missions. High-level, science-ready, public imaging data products and source catalogues are available for *INTEGRAL*, *XMM–Newton*, *Suzaku*, *HST*, ISO, Herschel and Planck.

As of 2 November, the total number of *INTEGRAL*-related refereed publications since launch is 957. Thus far in 2016, 57 new refereed papers using *INTEGRAL* data have been published.

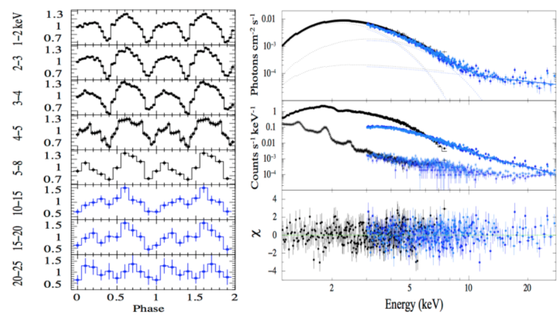
The Fermi Large Area Telescope has detected high-energy (0.1–100 GeV) gamma-ray emission during the exceptional outburst in 2015 of the closest black-hole X-ray binary transient V404 Cyg (Loh *et al.* 2016, MNRAS 462, L111). The gamma-ray emission occurred a few hours after the brightest radio flare seen from the source. The most significant gamma-ray emission period coincided with the brightest hard X-ray (80–150 keV) flare seen by IBIS/ISGRI. The detection of such gamma-ray production is a first for a low-mass X-ray binary. It is contemporaneous with the possible electron/positron annihilation reported from SPI observations (Siegert *et al.* 2016, Nature 531, 341). These observations indicate that the emitting region is located further away along the jet, since otherwise the emission would be absorbed due to pair production. This discovery supports the association of high-energy gamma-ray emission and mass ejections in X-ray binaries.

Over 100 scientists attended the 11th *INTEGRAL* Conference, "Gamma-Ray Astrophysics in Multi-Wavelength Perspective", which took place October 10–14 in Amsterdam, The Netherlands. The program provided a broad perspective on the findings of *INTEGRAL* in synergy with other space observatories The contributions will be published in Proceedings of Science. In view of the 15th anniversary of the launch of *INTEGRAL*, the next off-year *INTEGRAL* symposium (organized as usual by INAF-IAPS Rome) will take place in Venice, October 16–20, 2017.

NuSTAR

Daniel Stern (JPL), Fiona Harrison (Caltech)

The *NuSTAR* mission continues to operate nominally on orbit and to return exciting new science results. Recent highlights include *NuSTAR*'s contributions towards understanding the sources that make up the peak of the cosmic X-ray background. This study addresses one of the primary objectives of the *NuSTAR* satellite. Prior to *NuSTAR*, the directly resolved fraction of the background at its 25 keV peak was approximately 2%, with very few sources identified at redshift $z > 0.1$. As reported in Harrison et al. (2016, ApJ 831, 185), observations with *NuSTAR* have now directly resolved 33%–39% of the background at its peak, with sources identified out to $z = 3$. Other recent *NuSTAR* highlights include the discovery of an extreme pulsar in the supernova remnant RCW 103 with properties indicative of a magnetar, but with a spin period nearly 2500 times longer than any pulsar previously observed. This result, which used data from many of the currently operating high-energy facilities, demonstrates the strong synergies between the various missions, including monitoring with the *Swift* satellite, soft X-ray data data from *Chandra*, and high-energy data from *NuSTAR*.



X-ray lightcurves (left) and spectra (right) from NuSTAR (black) and Chandra (blue) of the central source in the supernova remnant RCW 103, which appears to be a magnetar-like object with an extremely long (6.67 hour) rotation period. Credit: X-ray: NASA/CXC/University of Amsterdam/N. Rea et al.

As we write these notes (mid-November 2016), the first public *NuSTAR* Science Meeting is being held at the California Institute of Technology, highlighting many results from the Guest Observer program. The Cycle 3 call for proposals was also recently released, with a due date of January 27, 2017.

Swift

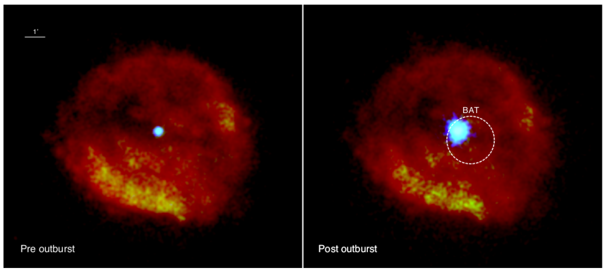
Eleonora Troja (GSFC), Lynn Cominsky (Sonoma State) and Neil Gehrels (GSFC)

The *Swift* mission continues to operate flawlessly. The mission was ranked number one in the 2016 Senior Review of NASA operating astrophysics missions (excluding *Chandra* and *Hubble*). The mission continues to support 4 Target of Opportunity (ToO) requests per day in addition to observing 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.

Astronomers used *Swift* data to create the first X-ray reverberation map of a tidal disruption event. The common belief was that, similarly to blazars, the observed high-energy emission originated from a narrow jet of particles accelerated to near the speed of light. The new study instead found that X-rays arise from the inner parts of the newly formed accretion disk, in a compact region near the central supermassive black hole. This technique allowed researchers to estimate the mass of the black hole at about a million solar masses.

Swift was instrumental in the detection and study of the extremely slowly rotating pulsar in RCW 103. On

June 22, 2016, the Burst Alert Telescope aboard *Swift* captured a short burst of X-rays from the supernova remnant RCW 103, likely produced by the neutron star at the center of the remnant. The source exhibited intense, extremely rapid fluctuations on a time scale of milliseconds, similar to magnetars. The source rotates once every 6.67 hours, a period nearly 2500 times longer than longest magnetar rotation period previously known. This period makes it the most slowly spinning neutron star ever detected.



Swift/XRT images of the supernova remnant RCW103 before (left panel) and after its June outburst (right panel) showing a remarkable increase in the brightness of the central compact object. The dashed circle shows the BAT localization (radius 1.2 arcmin) of the high-energy outburst, consistent with the position of the central neutron star. Credit: Swift Team; NASA

The *Swift* Cycle 13 GI program proposal deadline was September 23, 2016. NASA received 155 proposals for *Swift* Cycle 13, requesting a total observing time of 15.5 Ms and $5.0M in funds for 1,309 targets. Additionally, 32 proposals were received through the *Swift* GI joint programs. The *Swift* Cycle 13 Peer Review will be held in December. Cycle 13 observations will commence on or around April 1, 2017, and will last 12 months.

In May 2016, Lynn Cominsky gave a public lecture entitled "NASA's High-Energy Universe" to a large crowd in Ukiah, CA. This lecture featured many *Swift* images and was part of the supplemental program that accompanied a NASA museum exhibit in the Ukiah Public Library. Cominsky and Carolyn Peruta also did a hands-on "Girls who code" workshop with 8th grade girls at the Rosie the Riveter Historical Park Career Day. The object of the workshop was to help the girls to understand how to analyze imaging data from *Swift* and other instruments. NASA's newly funded Education Cooperative Agreement that represents all of Astrophysics includes Lynn Cominsky from Sonoma State University as a Co-investigator. *Swift* results will be included in Viewspace segments that are being created to highlight the multi-wavelength nature of objects like the Pinwheel galaxy (M101). One important part of NASA's new educational ecosystem is an increased emphasis on enlisting scientists to serve as Subject Matter Experts. If you are willing to volunteer to help with future webinars or to provide critical review of educational products, please e-mail Lynn Cominsky.

The Fermi Gamma-ray Space Telescope

Julie McEnery (GSFC), Elizabeth Hays (GSFC), Chris Shrader (GSFC & USRA), Dave Thompson (GSFC), Lynn Cominsky (Sonoma State U.)

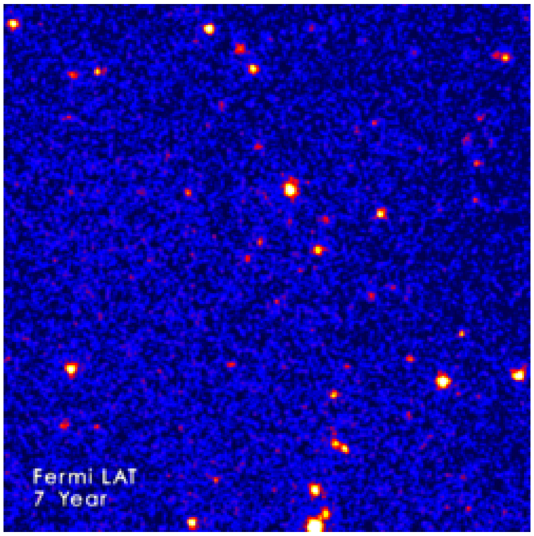
The *Fermi* Gamma-ray Space Telescope continues to operate nominally, and *Fermi* was approved for at least two more years of operation in the last NASA Senior Review. The Large Area Telescope (LAT) Pass 8 data provide substantial improvements in data quality over the entire mission. Pass 8 data, including updated software and documentation, are available through the Fermi Science Support Center.

Fermi continues to provide an ever increasing discovery space. The Large Magellanic Cloud especially continues to be a source of gamma-ray surprises. A notable example was the discovery in *Fermi*-LAT data of a new 10.3-day, high-mass gamma-ray binary system, LMC P3. LMC P3 is the first gamma-ray binary discovered beyond the Milky Way, and it has an extremely high luminosity compared to the gamma-ray binaries in the Galaxy.

Blazar PKS 1424−418 became a candidate source for one of the PeV neutrinos seen by IceCube. The neutrino direction is consistent (with very large uncertainty) with this gamma-ray blazar, and it arrived during a very high-fluence outburst seen in the *Fermi* LAT data. Another result involving blazars came from a comparison of *Fermi* LAT gamma-ray and WISE infrared spectra. Although separated by 10 orders of magnitude in energy, the blazar spectra seen by these two instruments turn out to be correlated.

Searches for particle dark matter continue to be important topics for *Fermi* investigations. Upper limits on various Weakly Interacting Massive Particle dark matter properties were recently derived from a study of the Small Magellanic Cloud and an analysis of the extragalactic gamma-ray background. The gamma-ray spectrum of NGC 1275 was used to search for signals of axion-Like particles, another potential dark matter candidate.

A total of 36 new guest investigations were selected for Cycle 9 out of 185 proposals received. Cycle 9 is currently ongoing and will continue until August 2017. The call for Cycle 10 proposals was recently issued and the submission deadline is February 24, 2017. A level of support similar to that for Cycle 9 is anticipated. Prospective proposers should be aware of the wide variety of scientific topics in which the *Fermi* community remains engaged and of the scope and variety of ground- and space-based joint observation programs offered in support of *Fermi* GIs. Additional information is available at the *Fermi* Cycle 10 Proposal website.



A portion of the Fermi 7-year sky map, used to put important constraints on the contribution of Weakly Interacting Massive Particles (WIMPs) to the extragalactic gamma-ray Background Light. Credit: Fermi Project; NASA; DOE

Seth Digel represented *Fermi* in the first scientific presentation to NASA's Museum Alliance. He presented *Fermi* results on the Galactic Center as part of a multi-wavelength tour of the Milky Way. Seminars to museum professionals are an important element of the Universe of Learning program, NASA's newly-funded Education Cooperative Agreement that represents all of Astrophysics, and which includes Lynn Cominsky from Sonoma State University as a Co-investigator. Look for more *Fermi* results in the future in Viewspace segments that are being created to highlight the multi-wavelength nature of objects like the Crab. One important part of NASA's new educational ecosystem is an increased emphasis on enlisting scientists to serve as Subject Matter Experts. If you are willing to volunteer to help with future webinars or to provide critical review of educational products, please e-mail Lynn Cominsky.

Suzaku

KOJI MUKAI (CRESST/UMBC & GSFC)

The final reprocessing of *Suzaku* data is now complete; the reprocessed data are now available both at HEASARC (NASA/GSFC) and at DARTS (ISAS/JAXA). The final reprocessing incorporates the final calibration of time-dependent detector properties of the XIS, including the gain and resolution and the contaminant build-up. These changes may well be noticeable for observations taken within the last year or so of the mission, but are expected to be minimal for data taken during the early phases of the mission. The calibration files used for final reprocessing have already been released through the HEASARC CALDB.

The X-ray Science Interest Group

MARK BAUTZ (MIT)

The X-ray Science Interest Group (XRSIG) met via telecon on June 8, 2016 to discuss NASA's response to the loss of *Hitomi*. More than 75 XRSIG members participated in a discussion with NASA Astrophysics Division Director Paul Hertz and Hitomi Soft X-ray Spectrometer (SXS) Principal Investigator Rich Kelley. In the course of this conversation Paul asked for community input on the scientific relevance and timeliness of the science return of a re-flight of the SXS. A summary of the telecon is available on the XRSIG web page.

A number of XRSIG members responded to this request by preparing a white paper entitled "The Scientific Signifcance of the Soft X-ray Spectrometer". The white paper discussed the extraodinary quality of the Perseus cluster spectra obtained by the SXS and concluded that "a re-flight mission with a launch no later than 2023 would fulfill the immense scientific promise of the Hitomi SXS." The document was endorsed by many members of the XRSIG and was summarized for NASA's Astrophysics Subcommittee in July. It is gratifying to note that NASA and JAXA have since engaged in extensive and positive discusions about NASA's possible role in a re-flight of the SXS. For more details, see the article on the X-ray Recovery Mission by Rich Kelley elsewhere in this newsletter.

As it does every year, the XRSIG supported the Physics of the Cosmos Program Analysis Group in summarizing the X-ray community's assessments of technology development needs for future strategic NASA missions. These assesments are forwarded (without prioritization) to NASA's Physics of the Cosmos (PCOS) Programs Technology Mangement Board, which establishes PCOS technology development priorities. The PCOS Program Annual Technology Report describes the process in more detail and presents this year's PCOS technology development priorities. Special thanks are due to XRSIG co-chair Ralph Kraft for leading XRSIG participation in this process.

The next XRSIG face-to-face meeting is planned for January 3, 2017 in conjunction the winter AAS meeting in Grapevine, TX. If you're interested in the XRSIG and its goings on, please subscribe to our mailing list.

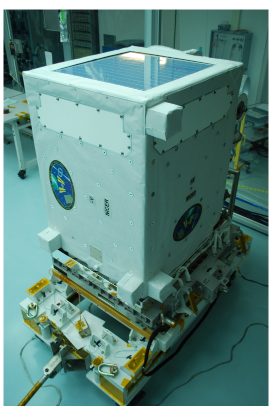
NICER

KEITH GENDREAU (GSFC), ZAVEN ARZOUMANIAN (GSFC & USRA)

2016 has been a "hurry up and wait" year for NASA's Neutron star Interior Composition Explorer (*NICER*). Manifested for launch on the SpaceX-11 Commercial Resupply Services flight to the International Space Station (ISS), where it will be an external attached payload, *NICER* is currently in storage at Kennedy Space Center awaiting launch no earlier than March 2017.

Designed to probe the extreme physics of neutron stars through high-precision timing and spectroscopy in the soft X-ray (0.2–12 keV) band, *NICER*'s flight hardware development at NASA/GSFC concluded in Spring 2016 as the project successfully navigated a Pre-Ship Review and the final phase of its ISS Payload Safety Review. *NICER* was delivered, by truck, to the Space Station Processing Facility at the Kennedy Space Center in early June, two weeks ahead of schedule. *NICER* is undergoing functional testing at KSC every 4-6 weeks to verify that the payload and its various systems remain healthy. While at Kennedy, *NICER* survived both Hurricane Matthew and the explosion on the launchpad of a SpaceX Falcon 9 rocket on September 1. The investigation into the Falcon 9 explosion has delayed the launch of *NICER*, and while return-to-flight activities are proceeding, a confirmed launch date has not yet been established.

In the meantime, back at GSFC, preparations for mission and science operations are nearly complete. Set-up of a HEASARC archive to store and disseminate *NICER* data is underway, and the maturity of procedures and tools developed for the *NICER* Science and Mission Operations Center enabled the team to pass its Operations Readiness Review in October. The *NICER* Science Team held a face-to-face meeting from September 26–28 at MIT to discuss the status of the mission and the science program.



NICER at KSC, during a successful functional test after Hurricane Matthew. Credit: NICER Project, K. Gendreau; NASA

Once installed on ISS and following on-orbit checkout for up to one month, *NICER* will turn its attention to completing its science and technology-demonstration objectives, by primarily targeting millisecond-period pulsars for observations with the X-ray Timing Instrument. The XTI offers a novel combination of capabilities: photon time-tagging to better than 100 ns RMS, energy resolution comparable to X-ray CCDs, high throughput (a telemetry limit exceeding 3 Crabs, with no pile-up), and good sensitivity. *NICER*'s peak effective area is 1800 cm^2 at 1.5 keV, and its broadband background countrate is expected to be substantially less than 1 count per second. The HEASARC tools WebPIMMS and WebSPEC can be used to predict source countrates and generate simulated *NICER* spectra.

As time allows during *NICER*'s 18-month baseline mission, and on a non-interference basis with its core science goals, the *NICER* team will consider requests from the community for Discretionary Time observations, including time-sensitive targets of opportunity. Such data will be promptly made public through the HEASARC archive, following the model of the *Swift* mission. Upon completion of the baseline mission, a dedicated *NICER* Guest Observer program is anticipated if *NICER* is approved for continuation through the NASA Senior Review process for ongoing astrophysics missions.

Spectrum Röntgen Gamma/eROSITA

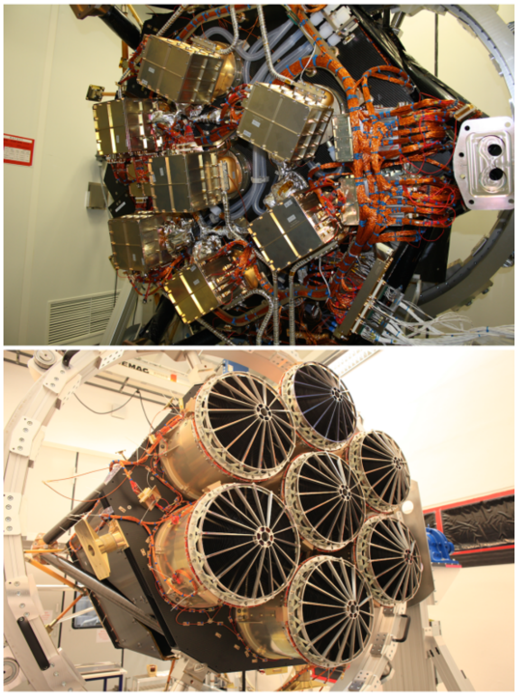
A. Merloni (MPE), M. Pavlinsky (IKI), P. Predehl (MPE), S. Sazonov (IKI)

The development of Spectrum Röntgen Gamma (SRG) is proceeding well. The spacecraft has been assembled in proto-flight configuration, waiting for the integration of the radio complex FM, expected in November 2016. The creation of the ground control segment is progressing according to plans. The launch vehicles are available, and the SRG launch is scheduled for December 2017.

The flight model of the ART-XC telescope has been assembled and the acceptance tests are expected to be completed by mid-November, whereupon the telescope will be delivered to the Lavochkin Association for integration with the spacecraft. Tests of spare units of the ART-XC X-ray mirror system and detectors are continuing at the calibration facility (a 60 meter long vacuum tube) at the Space Research Institute (IKI) in Moscow. Upon delivery and entry inspection of the ART-XC and eROSITA flight units at the Lavochkin Association, joint tests of the spare units of the mirror systems and detectors of both telescopes will be carried out at MPE's Panter facility in Germany. Launch of the SRG observatory is scheduled for the end of 2017.

The eROSITA flight model was fully assembled at MPE in September 2016, after which it left for the PANTER test facility south of Munich. There, it underwent an extensive end-to-end test campaign. At the time of this report, eROSITA is completely calibrated, assembled and tested. Everything is fully functional and within the expected/specified performances. More details on the outcome of the end-to-end test will be presented in the next issue of this Newsletter.

The final test campaign on the full telescope (vibration, mass properties and EMC) will take place at IABG in Munich in December 2016. After Christmas, eROSITA will undergo customs preparation and flight security procedures, before being flown to Moscow in early January 2017.



Pictures of the fully integrated eROSITA Telescope short before shipping to the PANTER facility for the final end-to-end test, in Summer 2016. Top: the focal plane assembly, with the seven electronic boxes for the seven pnCCD cameras plus the two interface and thermal controllers. Bottom: the seven mirror assemblies (baffles and mirror modules), before the integration of the structure front cover. Credit: eROSITA, SRG; IKI, MPE

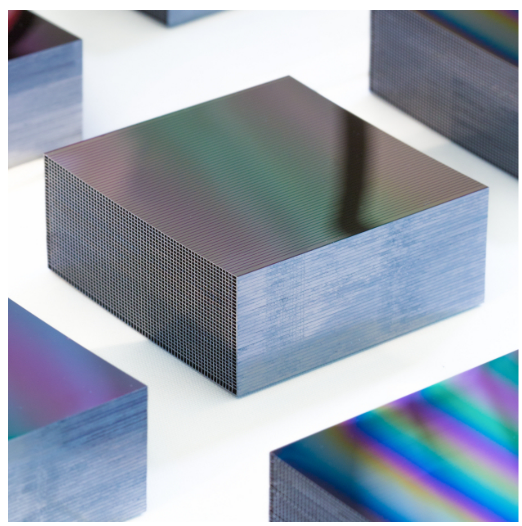
Athena: Revealing the Hot and Energetic Universe

KIRPAL NANDRA (MPE), XAVIER BARCONS (CSIC-UC), DIDIER BARRET (IRAP), AND RANDALL SMITH (CFA) FOR THE ATHENA SCIENCE STUDY TEAM

Athena is the X-ray observatory selected by ESA to be the second L-class mission of the Cosmic Vision 2015-2035 program, and due for launch in 2028. The mission continues to progress through Phase A, with recent major efforts by the ESA project team and instrument teams preparing for the upcoming Delta Mission Consolidation Review (dMCR) in December. An intensive study at ESA's Consolidated Design Facility (CDF) has just been completed, leading to a baseline design of the Focal Plane Module, accommodating the two instruments and their thermal control systems within the Athena satellite. The dMCR will review these efforts and the other open items from the MCR, and make recommendations to ESA management about how to proceed. The next major step will be the release of the Instrument AO by ESA, which is expected in early 2017. More information about the *Athena* mission and timeline is available at ESA's Cosmic Vision website.

The NRC's Mid-Decadal Review of NASA and the NSF's response to the 2010 Decadal Report "New Worlds, New Horizons" has recently been released. The review covered all areas addressed by the report, including X-rays, and noted in particular that "...*Athena* enables a compelling subset of the science envisioned for IXO and that participation in *Athena* therefore addresses the high priority given to IXO science by NWNH." They gave a specific recommendation (#4-5) that "NASA should proceed with its current plan to participate in *Athena*, with primary contributions directed toward enhancing the scientific capabilities of the mission".

In scientific terms, *Athena* will not operate in a vacuum, and the ASST (via the Athena Community Office) is working to organize a series of Synergy exercises to cover ways that Athena can work with other observatories that will be operating in the late 2020s. Community input is being obtained through workshops organized around the various facility classes. The first such meeting was the ESO-*Athena* Synergy Workshop, which took place September 16–18 at ESO in Garching. The Workshop was very successful, and a large number of areas of synergy (some unexpected) were discussed. The ESO-*Athena* Synergy Team went away with a lot of material and willingness to produce a White Paper. It has been decided that there will be a single ESO-*Athena* Synergy White Paper covering both optical/IR and sub/mm, which should be delivered in early 2017. A call for Expressions of Interest to participate in the SKA-Athena Synergy meeting has been released. Please e-mail the *Athena* Community Office (ACO) if you are interested in supporting this effort.



Silicon-pore optics mirror stack similar to that being developed for Athena. Shown is a stack of 35 mirror plates made of grooved silicon wafers. Silicon pore optics provide high throughput with good angular resolution in a lightweight design. Credit: cosine Research

In June, the re-vamped *Athena* community web portal was released. The web site contains updated information and resources in support of the *Athena* community, the remit and lists of Working Group and Topical Panel members, links to the *Athena* document repository and much more. The goal is to provide an active web portal, with news and announcements updated as frequently as needed. The portal includes *Athena* "Nuggets" covering various scientific and technical topics relevant to Athena, both with short write-ups and power-point slides suitable for inclusions in talks and lectures. If you would like a new topic to be addressed, feel free to email the ACO with your request.

There will be a call to join the *Athena* community Working Groups and Topical Panels in December 2016. Stay tuned with *Athena* activities through the web portal and follow us on twitter and facebook.

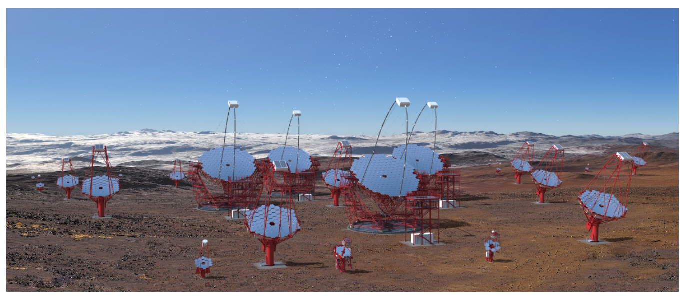
The *Athena* Science Study Team holds regular meetings to discuss the status of the mission with ESA; the next will be at ESTEC December 1st and 2nd, with a debrief to the *Athena* Working Group (WG) and Topical Panel (TP) Chairs to be held on December 13th. The *Athena* Science Study team also plans to hold yearly meetings with the Chairs; the next one will be February 22nd–23rd at SRON (Utrecht).

The Cherenkov Telescope Array

MEGAN GRUNEWALD (CTA)

The Cherenkov Telescope Array (CTA) is a worldwide initiative to build the next generation very-high energy gamma-ray observatory. Building on the technology of current generation ground-based gamma-ray detectors (H.E.S.S., VERITAS and MAGIC), CTA will be ten times more sensitive and have unprecedented accuracy in its detection of high-energy gamma rays. Current gamma-ray telescope arrays host up to five individual telescopes, but CTA is designed to detect gamma rays over a larger area and a wider range of views with more than 100 Cherenkov telescopes located in the northern and southern hemispheres. CTA's unique capabilities will help us to address some of the most perplexing questions in astrophysics. CTA will help us understand the role high-energy particles play in the evolution of cosmic systems, and will provide unique insights into the most extreme and unusual phenomena in the Universe. For example, CTA will enable searches for annihilating dark matter particles and deviations from Einstein's theory of relativity, and conduct a census of particle acceleration processes in the Universe.

CTA has made significant progress in 2016. Working prototypes exist or are under construction for all three classes of CTA's telescope designs, the northern hemisphere site negotiations have come to a close and significant site characterization is underway. The CTA Consortium has continued to grow, an agreement for construction and operation of the Observatory is in preparation, and funding for the project as a whole is progressing. On 19 September 2016, the Council of the Cherenkov Telescope Array Observatory (CTAO) concluded negotiations with the Instituto de Astrofisica de Canarias (IAC) to host CTA's northern hemisphere array at the Roque de los Muchachos Observatory in La Palma, Spain. The agreement allows the construction of the CTA northern array to proceed at the Roque de los Muchachos site and ensures access to the infrastructure and common services needed for the operation of the Observatory. Construction of a Large-Size Telescope prototype is currently underway on the La Palma site and can be watched live. Negotiations with the European Southern Observatory (ESO) for the southern hemisphere site near ESO's existing Paranal Observatory in Chile are expected to conclude before the end of 2016. If all goes as planned, construction in the south will begin in 2017, with first telescopes on site in 2018. Final telescope array layouts for both the northern and southern hemispheres have been fixed and now provide a basis for the sites' infrastructure design. In the southern hemisphere, preparations are underway for a topographical and geotechnical survey to take place during the first half of 2017. For the northern hemisphere site, arrangements are being made for conceptual design studies and electrical supply and lightning protection studies.



CTA design showing the Large-Size Telescopes (covering 20–200 GeV), Medium-Size Telescopes (100 GeV–10 TeV), and Small-Size Telescopes (few TeV up to 300 TeV). Credit: G. Pérez, IAC, SMM

In June, the CTA Observatory Council selected INAF-Bologna as the host site of the CTA Headquarters (HQ) and DESY-Zeuthen for the Science Data Management Centre (SDMC). The CTA HQ will be the central office responsible for the overall administration of Observatory operations and home of the Project Office, which will be relocating there from Heidelberg in 2017. The SDMC will coordinate science operations and make CTA's science products available to the worldwide community.

The CTA Consortium now includes 1,350 members from 210 institutes in 32 countries. This group of institutions is currently responsible for directing the science goals of the Observatory and is involved in the array design and in supplying components (as in-kind contributions). The Consortium held its bi-annual meetings in Kashiwa, Japan and Bologna, Italy this year with topics ranging from reports from the project work packages and CTA Project Office to Observatory operations and detailed science goals of CTA. A CTA Science Overview document is under final review and will be published in the coming months.

The new public CTA website was launched in October 2016. The site provides the latest news and materials from CTA, an in-depth look at CTA's science goals and expected performance, a project overview and status updates, the specifications of the technology behind CTA and much more. Visit the site, and sign up for the CTA e-mail bulletin to keep up-to-date with the latest CTA developments.

The X-ray Surveyor

DOUG SWARTZ (USRA & MSFC), JENNIFER GASKIN (MSFC)

X-Ray Surveyor is a large astrophysics mission concept identified for study as input to the 2020 Astrophysics Decadal Survey. The objective of the X-Ray Surveyor mission concept study is the delivery of a compelling and executable concept so that the science of this and other missions can be adequately prioritized by the Decadal Survey Committee.

The concept study is led by a Science and Technology Development Team (STDT) and enabled by a Marshall Space Flight Center-Smithsonian Astrophysics Observatory Study Office. The Study Team, which includes the STDT, is made up of over 30 individuals selected by NASA's Astrophysics Division from the science community and international observers from the Canadian, German, Italian, French, and Japanese space agencies as well as a representative from ESA. Since beginning the study, the STDT has established eight Science Working Groups, an Instrument Working Group and an Optics Working Group. Together, nearly 200 scientists from around the world are contributing through these ad-hoc panels. In particular, the Instrument Working Group will help the STDT translate science goals into technical instrument requirements, provide the STDT information and metrics needed to make scientific tradeoff decisions, and support the STDT in assessing technology readiness and preparing technology development plans and roadmaps. Similarly, the Optics Working Group will be responsible for assisting the STDT in demonstrating that a credible and feasible path exists to fabricate an X-ray telescope to support the X-Ray Surveyor science goals.

The first public face-to-face meeting among STDT members was held July 25–26, 2016 at the Smithsonian Center for Astrophysics in Cambridge, MA. The second meeting, held November 14-15, 2016, in Washington, DC, was dedicated to establishing an initial top-level science case for X-Ray Surveyor and identifying critical technology drivers. Plans are to deliver an interim report by December 2017 that provides the science case and mission concept for X-Ray Surveyor and delivers an initial technology roadmap with estimates for technology development cost and schedule. The public is invited to listen in on all STDT bi-weekly teleconferences and to attend the meetings as observers. We also invite you to join us at the X-ray Surveyor Spinter session at the AAS Winter meeting in Grapevine, Texas.

The Simulated Observations with X-ray Surveyor (SOXS) software package ia available to create simulated X-ray observations of astrophysical sources with the X-Ray Surveyor. See the X-ray Surveyor website for more information on X-ray Surveyor and the X-ray Surveyor Concept Study.

HEA-POEtry Corner:
Lurking in a Deep Field

Upon a midnight clear I wondered,
while I sat and pondered
Over many a quaint and curious volume of
forgotten lore;
When soon my wandering, glancing gaze
turned, and I was sore amazed:
a lightless patch of field not seen before.

Deep into that darkness peering,
long there staring, fearing.
When soon there came a tapping
light as rain, a gentle rapping
tapping upon my instrumental door.
An indistinct picture was slowly gathered,
downlinked, further examined:
Darkness there – and nothing more.

How in that darkness, seemingly unbroken,
still the stillness gave no token.
But slowly did the blackness shimmer,
gaping, did begin to glimmer
and a solemn dread did shake me to the core.

In that field of darkness yawning
was the birth of an ancient blackness dawning
hidden hideous beasts I now singularly saw.
Light enough, new signs of horror
Inclined I was by my own terror
To view this monstrous scene of celestial gore.

For in the dark, inexorable tentacles dangled
and even the incautious stars they mangled
who wandered too close to that horrible unseen shore;
screaming as they fell below me
hellish heat did only show me
destruction on a scale not seen before:

For sinking below that accursed horizon
End of both space and time arising
doomed worlds swallowed, to be seen,
quoth the raving,
Nevermore

— M. F. A. Corcoran

Have a contribution to the HEA-poetry Corner? Send it in!