The High Energy Astrophysics Division Newsletter

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From the Chair

Rob Petre (NASA/GSFC)

As I step into the HEAD Chair position, I want to thank all of you once again for the opportunity to serve the high energy astrophysics community. We are a vibrant and growing community, with a multitude of exciting future prospects (as evidenced by the contents of this newsletter and the recent HEAD meeting in Chicago this past March). I look forward to the next two years.

I'd like to thank my two predecessors, Chris Reynolds and Nick White, for their stewardship of HEAD. During Chris' tenure as chair, we had two highly successful meetings (and a solar eclipse) and exceeded the 1,000-member milestone. Chris stays on the HEAD Executive Committee as Past Chair, and we appreciate having him around to share his wisdom. Nick made many contributions to HEAD, most recently leading the nomination committee over the past two years, bringing us strong slates of candidates. Interestingly, all three of us have experienced major career transitions while serving as HEAD chair.

I would like to welcome the newest members of the Executive Committee and thank you for your willingness to serve: Vice Chair Fiona Harrison and Committee members Laura Brenneman and Gabby Gonzalez. And thank you to our two departing Executive Committee members, Liz Hays and Colleen Wilson-Hodge (who deserves congratulations for being named our latest Bruno Rossi Prize winner).

Needless to say, the most notable HEAD event over the past few months was the Chicago meeting. The objective of the meeting was to start the discussion about how HEAD as an organization should participate in the 2020 Decadal Survey of Astronomy and Astrophysics. I believe the meeting fulfilled this objective admirably, with nearly 200 in attendance. We reached far and wide to provide participants the broad backdrop of both the status of and prospects for high energy astrophysics in the 2020's and beyond. We heard invited and contributed talks offering views of the key scientific questions for the next decade. We also heard talks on current capabilities, capabilities under development, and capabilities under study for proposal to the decadal survey, from both the ground and space. Many of the talks were recorded and are accessible from the HEAD website; a first for HEAD, and something we hope to make a regular feature of meetings.

Based on the presentations and discussions at the Chicago meeting, the Executive Committee will draft a white paper about key high energy astrophysics questions for the 2020s over the next few months. We will circulate the draft for comments and invite interested astronomers to sign on.

The Executive Committee is now focusing its attention on the 2019 meeting, now set for Monterrey CA. We will celebrate anniversaries of some of our favorite missions there – Chandra's and XMM-Newton's twentieth, and Fermi's tenth (a bit late). These missions have demonstrated the value of strategic astrophysics missions, producing breakthrough results too numerous to mention in this brief column. We all hope that these missions will continue to serve us well for many years to come.

One of the Executive Committee's major near term objectives is improved outreach, with a variety of targets. We will continue our efforts to broaden the HEAD constituency to areas with whom we have obvious common

scientific interests. In particular, we want to increase our interaction with the physics side of the high energy astrophysics community by developing a stronger relationship with the American Physical Society Division of Astrophysics. We want to expand involvement by non-US members of the high energy astrophysics community by simplifying the affiliate membership application process. We want to reach out to the broader astronomy community by increasing awareness of how high-energy processes affect all aspects of astrophysics. We will reach out to the public by continuing the series of public lectures associated with our meetings and we will look into expanding public lectures to new venues. Most importantly, as part of our commitment to inclusiveness, we will be establishing liaisons with the various AAS committees, with the explicit aim of ensuring that we serve and welcome all in the greater AAS community.

HEADlines

MEGAN WATZKE (CXC)

From black holes to dark matter and everything in between, topics covered by HEAD missions continue to be the subject of articles in the popular (and social) media. In addition to press releases, there are many other opportunities for scientists to share their work and interact with the public. For examples, scientists from many HEAD missions and individual universities and agencies are involved in outreach to the broader citizenry, including presentations for local science festivals, educational programs, blogging and tweeting, and much more. We're always looking for volunteers. If you are interested in becoming active in education, public outreach, or publicity, please email mwatzke@cfa.harvard.edu.

Some of the recent newsworthy HEAD results during the past six months include:

October 30, 2017: NuSTAR Probes Black Hole Jet Mystery

December 19, 2017: A New Twist in the Dark Matter Tale

January 10, 2018: Scientists Take Viewers to the Center of the Galaxy

January 10, 2018: NASA's Newly Renamed Swift Mission Spies a Comet Slowdown

January 22, 2018: Three Types of Extreme-Energy Space Particles May Have Unified Origin

January 22, 2018: Study Shows First Evidence of Winds Outside Black Holes Throughout Their Mealtimes

February 26, 2018: XMM-Newton Spies First Clear X-ray Flares from Massive Stellar Lighthouse

February 28, 2018: Einstein@Home Discovers First Millisecond Pulsar Visible Only in Gamma Rays

April 2, 2018: Scientists Surprised by Relentless Cosmic Cold Front

April 4, 2018: New Study Suggests Tens of Thousands of Black Holes Exist in Milky Way's Center

April 18, 2018: Where is the Universe's Missing Matter?

April 25, 2018: NASA's Rossi X-ray Timing Explorer Spacecraft to Re-enter Over Tropics

The news offices of the various HEAD missions are always ready to help reporters trying to work on a story, or to help scientists prepare a press release for distribution. Please contact the relevant news office if you believe you have a potentially newsworthy result. If you don't know who to contact, please email mwatzke@cfa.harvard.edu.

LIGO-Virgo Scientific Collaborations

DAVID SHOEMAKER, LSC SPOKESPERSON; GUIDO MUELLER (U. FLORIDA)

After the rather spectacular close of the LIGO-Virgo O2 observing run in August and subsequent publications in the fall of 2017, the detectors have been in a commissioning mode in preparation for O3. The instrumental objectives for O3 are to bring the sensitivity of the two LIGO instruments to 120 Mpc reach for binary neutron star coalescences (SNR 8, averaged over sky position and polarization) and of the Virgo instrument to 60 Mpc. This is achieved for LIGO through an increase in the laser power, the use of squeezed light to further reduce quantum noise, replacing some of the test-mass mirrors, adding some baffling, and addressing a handful of other limitations to sensitivity. Virgo is undertaking a similar program, including the introduction of fused-silica fiber suspensions to reduce the thermal noise. The instruments are expected to be ready for an early 2019 start to O3, which is planned to last approximately one year.

A significant change from the perspective of EM and particle observers is the plan for Public Alerts in O3. The Virgo and LIGO Scientific Collaborations (LVC) will join the GCN/TAN system to provide alerts with very low latency for significant gravitational-wave triggers, with more refined information (e.g., skymaps) to follow. The hope is to expand the range of follow-on observations to ensure the maximum scientific return from all detected events. During two town hall meetings held this spring, the collaborations received a number of useful comments, questions, and ideas. These ideas are being folded into the plans for the Public Alerts and the best general approach to use to alert the non-GW astrophysics community. Preparations for the mechanics of these Public Alerts as well as refinements of the waveforms, data analysis codes, and parameter estimation techniques are an intense focus of our work. Work also continues on the analysis of data from the O2 run, with a number of publications in the pipeline to document and summarize the results.

There is still a lot of work to do between now and the start of O3 in early 2019. We look forward to exciting results from O3, which will undoubtedly be of great interest to all those intrigued by gravitational waves and the systems that produce them.

A trio of happy physicists. Credit: the Nobel Foundation

Laser Interferometer Space Antenna

Ira Thorpe (NASA/GSFC), Guido Mueller (U. Florida)

Inspired by the successes of their colleagues in ground-based gravitational wave interferometry, the space-based gravitational wave community has been moving full steam ahead in the development of the Laser Interferometer Space Antenna (*LISA*) mission. This ESA-led mission passed its Mission Formulation Review in December of 2017, clearing the way for a new start. In the Spring of 2018, ESA solicited bids from industry to conduct mission formulation studies over the next few years. In May it was announced that both Airbus Defense and Space in Friedrichshafen, Germany and Thales Alenia Space in Turin, Italy had been selected to conduct parallel studies that will define the spacecraft architecture and form the basis for the implementation phase of the mission.

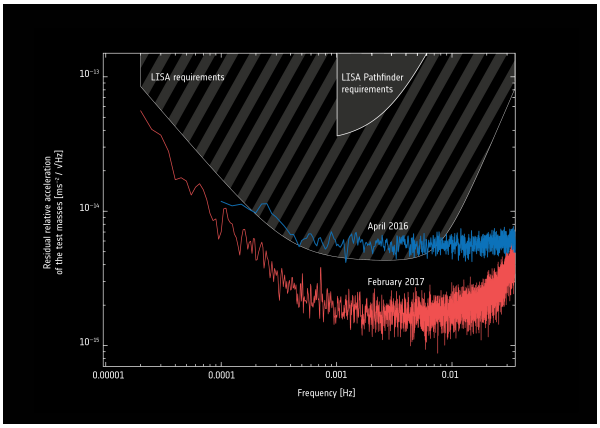
The first half of 2018 has also seen significant changes in the *LISA* Consortium. Formerly a loose grass-roots organization of *LISA* enthusiasts who were responsible for the 2017 *LISA* Mission Concept Proposal, the *LISA* Consortium is evolving into an entity that will have a substantial role in the mission. This role will include delivery of key elements of the instrument payload, funded by European National agencies, as well as essential parts of the analysis infrastructure and science framework. The first general meeting of this rebooted Consortium was held in Hannover, Germany this past April. The *LISA* Consortium is now accepting applications for researchers who want to actively contribute to the mission.

The *LISA* Pathfinder team continues to publish new results, including an update of the acceleration noise performance published in February 2018 (Phys. Rev. Lett. 120, 061101) that showed a marked improvement over the initial results published in 2016. These incredible results clearly demonstrate that the technology of freely-falling test masses in a drag-free satellite can be used to create the low-disturbance environment necessary for detecting gravitational waves.

In the US, NASA has been actively supporting LISA-related work on a number of fronts. The *LISA* Study Office continues to develop technologies which support potential contributions to the *LISA* flight system. These include ultra-stable telescopes, stable and reliable metrology lasers, low-noise electric micropropulsion systems, precision phase measurement systems, and non-contact charge control systems based on UV light. In addition, the Study Office has been conducting analyses to identify potential non-payload contributions that will help enable a capable and timely *LISA* mission.

On the science side, NASA announced the *LISA* Preparatory Science (LPS) funding opportunity as part of the FY19 ROSES call. LPS will fund LISA-related research in analysis, gravitational wave science, and related astrophysics that will help refine the *LISA* science case and develop tools that can be infused into the *LISA* mission. The US *LISA* Community, headed by the NASA *LISA* Study Team (NLST), is busily preparing the case for *LISA* in the 2020 Decadal Survey of Astronomy and Astrophysics. In addition to several informal whitepaper hack-a-thons, the NLST will conduct its next full meeting in late August in Baltimore, MD. This will be a joint meeting with ESA's *LISA* Science Study Team.

Last but not least, the 12th International *LISA* Symposium will be held in Chicago, IL, July 8-13. This once-every-other-year event covers the full range of *LISA* research, including mission development, technologies, data analysis, theory, astrophysics, and results from related missions.



The final estimate of the differential acceleration noise between the two LISA Pathfinder test masses showed significant improvements over the initial result and met the requirements for LISA over the entire measurement band. Credit: ESA/LISA Pathfinder Collaboration

IceCube

Carsten Rott (Sungkyunkwan University)

The IceCube neutrino telescope instruments a volume of about one cubic-kilometer of ultra-pure Antarctic ice, and can detect neutrinos with energies of a few GeV (10^9eV) using the DeepCore in-fill array to energies well above 1 PeV (10^{15}eV). IceCube is a multipurpose experiment that covers an extremely broad scientific spectrum. The search for physics beyond the standard models is one

of the main objectives of the experiment. Among the recent achievements in this field are some of the strongest bounds on dark matter scattering with protons, based on searches for dark matter captured in the Sun, constraints on self-annihilating dark matter from the Galactic halo, and strong bounds on the flux of monopoles.

One of the major scientific accomplishments of IceCube so far has been the observation of high-energy astrophysical neutrinos from beyond our solar system, revolutionizing the field of astroparticle physics. The observed neutrino spectrum measured by IceCube defies any standard explanation, and perhaps requires new physics beyond the standard model.

The struggle to understand the elusive nature of dark matter is at the forefront of modern physics. Attempts to constrain the properties of dark matter with particle colliders, underground experiments, and telescopes so far have mostly come up empty. There have been suggestions that the highest energy astrophysical neutrinos could be produced by certain models of heavy dark matter decay. The IceCube Collaboration has now made one of the strongest tests of heavy dark matter decay, using independent searches of six years of muon-neutrino tracks from the Northern Hemisphere and two years of all-flavor neutrino cascades from the full sky. This analysis found no evidence that high energy neutrinos originate from decaying dark matter, providing a stringent lower limit of the lifetime for dark matter particles with a mass of 10 TeV or above. Lifetimes shorter than 10^{28} seconds (about 10 billion times the age of the universe) have been excluded. Besides setting some of the most stringent bounds on the dark matter lifetime, this study also concluded that dark matter alone cannot explain the observed high-energy neutrino flux seen by IceCube.

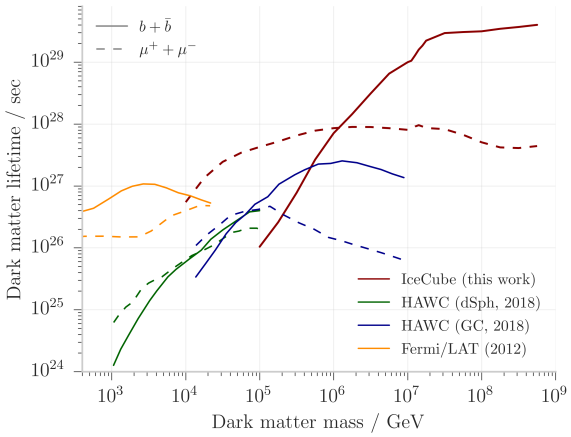


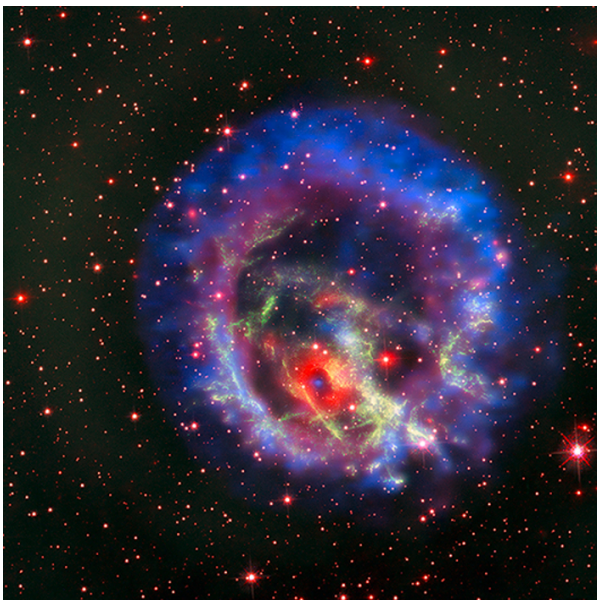
Figure 1. Comparison of the lower lifetime limits with results obtained from gamma ray telescopes: HAWC (Dwarf Spheroidal Galaxies), HAWC (Galactic Halo/Center) and Fermi/LAT. Image: IceCube Collaboration

IceCube results on the search for dark matter are very complementary to searches using high-energy gamma rays done by Fermi-LAT and the High Altitude Water Cherenkov (HAWC) array. Further IceCube analyses, with improved sensitivities and utilizing larger datasets, are on-going. New results will be presented at the Neutrino 2018 conference. In the future, the IceCube-Gen2 detector will significantly enhance the sensitivity for neutrinos from heavy dark matter decay, and is expected to lead to a more complete understanding of the nature and origin of astrophysical neutrinos.

The Chandra X-ray Observatory

ROGER BRISSENDEN (SAO) AND MARTIN C. WEISSKOPF (NASA/MSFC)

The *Chandra* X-ray Observatory has carried out more than 18 years of highly successful and productive science operations. The *Chandra* X-ray Observatory 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 astrophysical investigations. The Project is looking forward to many more years of scientific productivity. NASA has chosen to continue the mission, and SAO and MSFC are working to extend the contract to operate the *Chandra* X-ray Center potentially through September 2030.



Chandra and VLT/MUSE discovery of an isolated neutron star in E0102, the first such object discovered outside the Milky Way. The isolated neutron star is the blue X-ray source at the center of the red ring detected by MUSE. Credit: X-ray (NASA/CXC/ESO/F. Vogt et al.); Optical (ESO/VLT/MUSE & NASA/STScI).

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 also to progressive degradation of the spacecraft's multi-layer insulation. Condensation on the filter reduces ACIS's sensitivity to low-energy X-rays (but does not affect the HRC). Recent measurements indicate that the accumulation rate of the contamination has

decreased over the past year. The decline in insulation effectiveness requires extra effort in scheduling observations but has not significantly affected *Chandra*'s observing efficiency.

The *Chandra* Operations Control Center (OCC), from which mission operations are conducted, will be moving from its current site in Cambridge, Massachusetts to Burlington, Massachusetts. Contractors are currently renovating the new space, and the OCC team is carefully planning to ensure a smooth continuation of *Chandra* operations throughout the move, currently scheduled for completion in March 2019.

Release 2.0 of the *Chandra* Source Catalog (CSC) is nearing completion. Key data for all 374k detected sources (including positions, likelihoods, amplitudes and associated errors) are available through the CSC2 website, with source properties for about 75% of the objects available as of May. Properties for the remaining sources will be added to the catalog as they are processed. The CSC2 website provides access to the Release 2 data, as well as documentation that describes the organization and content of the catalog, including important information that should be reviewed prior to using the catalog data.

In December 2017, the *Chandra* X-ray Center (CXC) issued a call for proposals for Cycle 20 observations, with a deadline for proposals in March 2018. Scientists worldwide submitted a total of 530 proposals, including 434 observing proposals and 96 proposals for archive and theory research. The observing proposals requested a total of 9.9 Msec of telescope time, an oversubscription factor of approximately 6. The Cycle 20 peer review will be held in June.

In December the CXC also issued a special call for proposals for new *Chandra* observations bearing on a potential *Chandra* successor mission (CSM). Such observations might demonstrate the feasibility of key CSM goals or enhance CSM science prospects. We expect the results of these pathfinder studies to aid the 2020 Astrophysics Decadal Survey Committee in judging CSM science. The observations will use a portion of 2018 *Chandra* Director's Discretionary Time. 29 proposals requesting 9.5 Ms of observing time were submitted, and three proposals, for a total of 446 ks, were approved.

NASA announced the selection of 24 Fellows for the 2018 NASA Hubble Fellowship Program (NHFP), which supports postdoctoral researchers performing research across all of NASA astrophysics. NHFP postdocs are named as Hubble, Einstein, and Sagan fellows, depending on their research focus. Seven of those selected for 2018 were named as Einstein Fellows. Current Einstein Fellows will present their recent work at the Einstein Fellows Symposium, to be held at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Massachusetts, on 2 – 3 Oct, 2018.

The CXC will host a workshop, "Accretion in Stellar Systems" at the Center for Astrophysics, 8 – 10 August, 2018. The workshop will bring together researchers working on accretion, outflows, and related processes in diverse astrophysical objects. Its focus will be on understanding how accretion and ejection work and how they affect stellar evolution, and on identifying important unanswered questions and promising future research directions. The workshop will include a special session dedicated to the late Jeffrey McClintock's legacy to the field.

The *Chandra* Press Office has been active in issuing image releases, science press releases and other communications of *Chandra* research results. Volume #24 of the annual Newsletter was published in April.

XMM-Newton

Lynn Valencic (JHU & NASA/GSFC)

Successful submissions from the Seventeenth Call for Proposals for XMM-Newton were announced in December 2017, and observations will begin in May. The Eighteenth Call for Proposals will open August 21, and the final date to submit proposals will be October 5. The final approved program will be announced in mid-December.

The SOC is hosting a workshop June 13 – 15 in Villafranca del Castillo, Madrid, Spain. It will focus on the topic of "Time-Domain Astronomy: A High Energy View". The workshop will summarize the current understanding of the variability of high energy sources and examine potential synergies with other time-domain facilities (such as Gaia, LSST, ASAS, TESS, and PanSTARRS), with the goal of promoting collaborations across multiple wavelength bands. Proceedings and presentations from the 2017 symposium, "The X-ray Universe" are now available online. As always, recent science results from *XMM–Newton* are available from the *XMM–Newton* Latest News web page.

The Neil Gehrels Swift Observatory

Eleonora Troja (NASA/GSFC), Brad Cenko (NASA/GSFC)

The *Swift* Gamma-Ray Burst Explorer has officially been renamed the Neil Gehrels *Swift* Observatory. NASA announced the re-christening of *Swift* at the 2018 winter AAS meeting to honor Neil Gehrels, the guiding force behind the development of the observatory, and who served as *Swift*'s principal investigator until his death on February 6, 2017. The Neil Gehrels *Swift* Observatory remains the go-to facility for rapid-response, multi-wavelength discovery and follow-up of time-variable sources.

The mission continues to operate flawlessly. It supports four Target of Opportunity (ToO) requests per day in addition to observing gamma-ray bursts (GRBs) and Guest Investigator (GI) targets. *Swift* is by far the most active mission in terms of the number of ToOs accepted and different sources observed.

Observations by the Neil Gehrels *Swift* Observatory have captured an unprecedented change in the rota-

tion of the comet 41P/Tuttle-Giacobini-Kresàk – 41P for short. Estimated to be less than 0.9 miles (1.4 kilometers) across, 41P is among the smallest of the family of comets whose orbits are controlled by Jupiter. Images taken in May 2017 reveal that 41P was spinning nearly three times slower than it was in March. The abrupt slowdown is the most dramatic change in a comet's rotation ever seen. Because *Swift*'s Ultraviolet/Optical Telescope (UVOT) is sensitive to UV light emitted by hydroxyl, it is ideally suited for measuring how comet activity levels evolve throughout the comet's orbit. *Swift*'s UVOT imaged the comet from May 7 to 9, revealing light variations associated with material recently ejected into the coma. UVOT-based estimates of 41P's water production, coupled with the body's small size, suggest that more than half of its surface area contains sunlight-activated jets. That's a far greater fraction of active real estate than on most comets, which typically support jets over only about 3 percent of their surfaces.

The *Swift* Guest Investigator (GI) program will continue to solicit proposals in GRB and non-GRB research during Cycle 15. NASA's Research Opportunities in Space and Earth Sciences (ROSES) 2018 and the Swift Appendix were released on February 14, 2018. The deadline for submitting Swift Cycle 15 GI Program proposals is September 27 at 4:30 PM EST. Please visit the Swift Proposals web site for more details.

NuSTAR

Daniel Stern (JPL), Fiona Harrison (Caltech)

The *NuSTAR* mission continues to operate nominally on orbit and maintains a high degree of scientific productivity. The 450th refereed paper reporting on *NuSTAR* results was recently accepted, and *NuSTAR* Cycle 4 approved targets are available from the *NuSTAR* HEASARC website. As of this writing, 96% of approved Cycle 3 *NuSTAR* observations have been completed, including all non-ToO, non-coordinated category A and B observations. Most of the category C observations have also been completed. *NuSTAR* Cycle 4 observations began on May 15, and *NuSTAR* joint observations awarded in *XMM–Newton* Cycle 17 will begin on June 6.

Since the last HEAD Newsletter, *NuSTAR* constituted a *NuSTAR* Users' Committee (NUC), a group of 10 astrophysicists representing a wide range of community interests. The NUC will provide the *NuSTAR* project with broad-based input about the needs and priorities of the *NuSTAR* user community during the extended operational mission phase. The inaugural chair of the NUC is John Tomsick (UC-Berkeley), and the full membership of the NUC is listed on the *NuSTAR* User's Committee webpage. The NUC is the primary interface between the *NuSTAR* community and the *NuSTAR* project and NASA headquarters. It assists the project during *NuSTAR*'s operational phase, and helps in preparing for upcoming Senior Reviews. The NUC will nominally meet twice a year, and provide a forum for the *NuSTAR* Guest Investigator community to provide feedback to ensure the interests of the community are served by the *NuSTAR* Science Operations Center in planning for and executing *NuSTAR* operations. We encourage any users with concerns or comments to email the NUC.

The Neutron Star Interior Composition Explorer

Keith Gendreau (NASA/GSFC), Zaven Arzoumanian (NASA/GSFC)

June marks the first anniversary of the launch of NASA's Neutron star Interior Composition Explorer (*NICER*), an X-ray astrophysics payload on the International Space Station. Science operations began in July 2017, and *NICER* continues to operate nominally, conducting its 18-month baseline mission of exploring neutron stars in all of their manifestations. As observing time and efficiency permit, a broader suite of science investigations targeting black holes, active stars, and other X-ray phenomena is also being pursued. Notable early results include:

- Discovery of millisecond pulsations from the low-mass X-ray binary (LMXB) IGR J17379-3747, and measurement of its orbital period (Strohmayer et al., ATel #11423)
- Tracking the full spectral evolution of a photospheric-radius-expansion burst in the LMXB 4U 1820-30 (Keek et al., ApJ 856, L37)
- Confirmation of IGR J17062-6143 as an ultracompact accreting millisecond pulsar, with the shortest known orbital period (38 minutes) among this class of objects (Strohmayer et al., ApJ 858, L13)
- Evidence, from joint spectral-timing analysis, for intrinsic accretion-disk variability driving nonthermal modulations in the hard state of Aql X-1 (Bult et al., ApJ 859, L1)
- Characterization of relativistic disk reflection features at iron K and L-complex energies in the LMXB Serpens X-1 (Ludlam et al., ApJ 858, L5)
- Measuring the impact of a Type I X-ray burst on the accretion environment in the LMXB Aql X-1 (Keek et al., ApJ 855, L4).
- In addition, NICER's SEXTANT (Station Explorer for X-ray Timing and Navigation Technology) team demonstrated for the first time the use of millisecond pulsars for autonomous deep space navigation.

An Astrophysical Journal Letters Focus Issue compiling these and other early results is in preparation—we

encourage readers to check in periodically for new content.

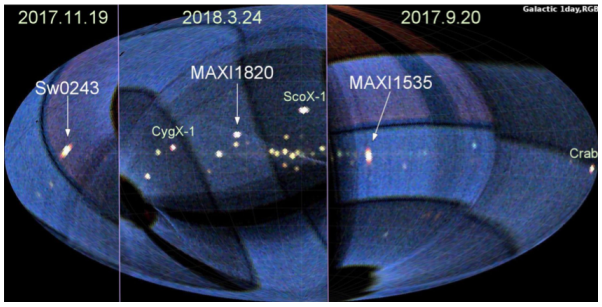
NICER data have been available in the public HEASARC archive since mid-March 2018, and new datasets are delivered to the archive within two weeks of the observation. (Exception is made for certain target investigations that are especially sensitive to calibration uncertainties.) Mission-specific data analysis tools, together with upgrades to traditional FTOOLS software to make them *NICER*-aware, are distributed within recent releases of the HEASoft software package. Refinements to early *NICER* calibration products are ongoing.

While focused on its baseline-mission science through the remainder of 2018, *NICER* is open to requests for Target of Opportunity (ToO) observations as well as time-constrained Discretionary Time requests; see the *NICER* home page for details. Pending the successful passage of a Mission Success Progress Review, *NICER* anticipates operating a Guest Observer program between January and September 2019, as described in the ROSES 2018 D.12 *NICER* Cycle 1 solicitation—the due date for proposals has not yet been established. Any further extension of the *NICER* mission will be determined by the NASA Astrophysics Senior Review process.

MAXI

TATEHIRO MIHARA (RIKEN)

Monitor of All-sky X-ray Image (*MAXI*) on the Japanese module of the International Space Station (ISS) has been continuously monitoring the whole X-ray sky since 2009 August in the 2–20 keV energy range. The scan interval is 92 minutes (the ISS orbital period) and the sky coverage is 95% per day. *MAXI* has real-time ground contact for about 70% of the time. Nova and other transient alerts are issued from RIKEN to the world, and *MAXI* processed data are available from the MAXI home page.



All-sky map in galactic coordinates composed of three 1-day MAXI images. Three bright novae appeared.in each image. The dates are when the sources were at the maximum. All of them exceeded 1 Crab.

MAXI obtained the earliest upper limit on X-ray emission from the neutron-star binary merger kilonova which produced the gravitational wave event GW170817 (Sugita et al. 2018), in an observation only +4.6 h after the gravitational wave trigger. Although *MAXI* happened to be scanning the exact region of the sky in which the kilonova is located just 20–130 seconds after the event, the detector high voltage was switched off because *MAXI* was in a region of high particle background at that time. *MAXI* observations resumed at 170s after the event but by then the source was no longer in *MAXI*'s field of view.

September 2017 through March 2018 were especially busy and exciting months for *MAXI*, with a rush of new transients. The first to note was *MAXI* J1535-571 on September 2, 2017. *MAXI*'s trigger occurred first at 14:40 UT, followed by a Swift/BAT trigger at 20:00 (Markwardt GCN 21788). We reported a second *MAXI* trigger at 23:55 (Negoro ATel. #10699). Discovery is thus really competitive. *MAXI* J1535 reached 6 Crab in late September and became the 7th brightest in history, or the brightest X-ray nova of this young century. The source turned out a black hole (BH) binary, and many coordinated observations were carried out by various instruments (including *Swift*, *NICER*, *NuSTAR*, *HXMT*, etc.) to study soft-hard spectral transitions and QPO frequency changes. The source faded below the *MAXI* detection threshhold on April 16, 2018 (Negoro ATel. #11568).

The second September transient was Swift J0243.6-6124. MAXI detected this source on September 29. Because the location was consistent with a known source, LS I +61 303, we initially reported it as a brightening of this source (Sugita ATel #10803). But when *Swift*/BAT triggered on October 3, the *Swift* XRT found a new source with a 9.86 s pulsation as well (Kennea GCN 21963, ATel #10809). This source turned out to be an X-ray binary pulsar with a Be star. *Swift* J0243 brightened up to 10 Crab in early November, and became the brightest neutron star binary in this century.

Another important *MAXI* transient to note were *MAXI* J1621–501 (NS-LMXB), detected on October 19, 2017, *Swift* J1658.2–4242 (BH binary) detected on February 16, 2018, and *MAXI* J1813–095 (BH binary), detected on February 20, 2018. Perhaps the most interesting transient discovered was *MAXI* J1820+070, discovered on March 11, 2018 (Kawamuro ATel #11399). An optical candidate was reported 4 h before the *Swift*/XRT follow-up. Optical, radio, and X-ray observations revealed this source to be a BH binary. Its flux increased to 2 Crab in late March. The variability of this source was very violent, similar to the extreme variations seen in GRS 1915+105 and V404 Cyg. Flares of 10 ms duration were detected in followup observations with X-ray with *NICER* and also by large optical telescopes on the ground.

In addition to these stand-out transients *MAXI* has detected some mysterious rapidly decaying X-ray transients. These were bright and detected at high significance with *MAXI*, but not detected in *Swift*/XRT follow-up observations half a day later. We call these transients *MAXI* Unidentified Short Soft Transients (MUSSTs). *MAXI* has detected 8 MUSSTs in 5 years. A key to understanding the nature of a MUSST source is to "watch it in X-rays while it

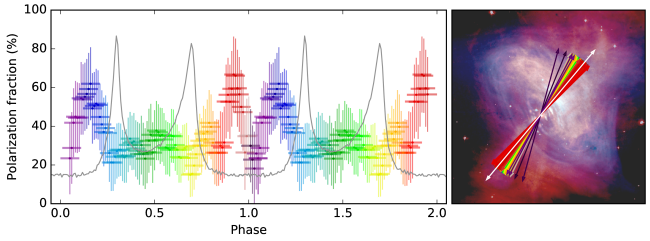
is still X-ray bright". To realize quick X-ray follow-up, we are planning to send real-time alerts to *NICER* (*MAXI*'s neighbor on the ISS) for rapid, sensitive observations at soft X-ray energies.

AstroSat

DIPANKAR BHATTACHARYA (IUCAA, PUNE), K. P. SINGH (IISER MOHALI)

Observing proposals for *AstroSat* cycle A05 (Oct 2018 – Sep 2019) were received by March 23rd, 2018 and are currently undergoing review. 20% of the observing time during this cycle will be awarded to international proposals.

AstroSat has suffered some unfortunate setbacks recently: The Near Ultraviolet (NUV) channel of the Ultraviolet Imaging Telescope (UVIT) developed a communication malfunction and is currently not operating. Revival efforts are ongoing, and the Far Ultraviolet (FUV) and the Visible (VIS) channels of UVIT continue to function normally. One of the three units of the Large Area X-ray Proportional Counter (LAXPC) has ceased operation due to a gas leak. The other two units are available for observations.



Left: Degree of polarization as a function of pulse phase (colored bars) and the intensity profile (grey line) of the Crab pulsar as observed by AstroSat CZTI. Right: The position angle of hard X-ray polarization shown superposed on a composite Chandra and HST image of the Crab nebula. The white arrow represents the projected spin axis of the pulsar, and the others display the orientation of the observed polarization. The color of an arrow indicates the corresponding phase range as displayed in the left panel. Credit: AstroSat; NASA

One of the recent *AstroSat* science highlights is a study of phase-resolved polarization of the Crab pulsar. This has been performed with the Cadmium Zinc Telluride Imager (CZTI) instrument, in the energy range 100-380 keV. Accumulation of 800 ks of CZTI data over 18 months provided the most sensitive measurement of Crab polarization so far in this energy range. The key findings are (1) at the phase resolution afforded by the data, the polarization vector of the high energy emission remains nearly aligned throughout the pulse period, and (2) the polarization vector is almost coincident with the projection of the pulsar's spin axis in the sky. These features are consistent with recent theoretical suggestions that most of the high energy emission originates in the pulsar's wind zone, beyond the conventional magnetosphere. The average degree of polarization is measured to be ∼39% with a possible hint of variation during the "off-pulse" phase. These results are reported in Nature Astronomy (vol 2, p. 50).

The Fermi Gamma-Ray Space Telescope

JULIE MCENERY, ELIZABETH HAYS, DAVE THOMPSON (NASA/GSFC), CHRIS SHRADER (CRESST/CUA & NASA/GSFC), LYNN COMINSKY (SONOMA STATE U.)

The *Fermi* Gamma-Ray Space Telescope is celebrating its tenth year of operation in 2018, having been launched on 11 July, 2008, and having started regular science operations on 4 August, 2008. The Eighth International *Fermi* Symposium will be held in Baltimore from 14 – 19 October as part of this celebration. *Fermi* results continue to span a broad range of topics, with studies carried out by the national and international science community.

Recent operations have been eventful. *Fermi* encountered an issue with one of its solar array drives that halted operations for about two weeks in March. Regular science operations have resumed, with some (hopefully temporary) constraints on observation modes. Investigation continues into the root cause of the issue and possible workarounds.

Cycle 11 proposals were received in February and are currently in review. Additional information is available at the *Fermi* Science Support Center website, and results should be announced in the near future. As usual, current *Fermi* software and documentation are also available through the *Fermi* Science Support Center.

The past six months have been scientifically notable. Dr. Colleen Wilson-Hodge and the *Fermi* Gamma-Ray Burst Monitor team were awarded the 2018 Bruno Rossi Prize by the HEAD for the GBM's discovery of gamma rays coincident with a neutron-star-merger gravitational wave event detected by LIGO. This observation confirmed a long-standing theory that short gamma-ray bursts are produced by binary neutron-star mergers. The Einstein@Home distributed computing project, using *Fermi* LAT data, discovered the first millsecond pulsar with no detectable radio emission.

Fermi Astrophysics participated in the NASA events at the USA Science and Engineering Festival in Washington, DC from 6 – 8 April, 2018. The *Fermi* booth featured photo opportunities with the new "*Fermi* 10th Anniversary" banners. Hundreds of students and their families learned about *Fermi*'s observations of pulsars and were engaged in creating model pulsars, which were displayed in the photo shoots. Dr. Elizabeth Ferrara organized the booth and also gave a hyperwall presentation during the Festival, which brought over 300,000 attendees to the Convention Center during the weekend.

As part of NASA's Universe of Learning, Dr. Lynn Cominsky featured *Fermi* science in a presentation to the

Microsoft DigiGirlz program. Universe of Learning targets girls who are learning to code to introduce them to STEM career paths, as part of the program "Girls STEAM Ahead with NASA." Dr. Cominsky also gave public lectures at Ukiah High School, Chico State University, Sonoma State University, Humboldt State University, and the Mt. Diablo Astronomical Society highlighting *Fermi*'s discovery of the gamma-ray burst associated with the binary neutron merger that produced the gravitational wave signal GW170817. She also gave a series of *Fermi*-inclusive lectures in Taipei, Taiwan, and gave the education keynote about work with *Fermi* to the Astronomical Society of the Republic of China in May.

INTEGRAL

ERIK KUULKERS (ESA/ESTEC) AND STEVE STURNER (CRESST/UMBC & NASA/GSFC)

The *INTEGRAL* spacecraft, payload and ground segment have generally been performing nominally over the period covered. At the November 2017 and March 2018 ESA Science Programme Committee (SPC) meetings, *INTEGRAL* was indicatively approved for operations through the end of 2020. SPI annealing #30 was conducted from 27 January to 12 February with a satisfactory recovery. The Gaia, *XMM–Newton*, and *INTEGRAL* Space Control (Spacon) merger will begin on 11 April, pending a positive Go/NoGo-review meeting the day before. Meeting #20 of the *INTEGRAL* User Group (IUG) took place at ESTEC on 21 – 22 February with the the next mission extension as the primary topic. Peter von Ballmoos's term as IUG chair ends on 1 July. He will be succeeded by Lorrain Hanlon (UCD, Ireland). The next IUG meeting will be held at ESTEC on 7 – 8 November. Moving forward, the IUG's main focus will be on multi-messenger astronomy, supporting new gravitational-wave facilities, as well as wide-field observatories at other wavelengths. *INTEGRAL* is well suited for catching the prompt electromagnetic counterparts to fast transient events.

Internal testing of OSA 11 by the instrument teams is almost complete and the results are promising. The release is imminent with a delivery date to be agreed upon soon. A large coordinated high-energy cross-calibration campaign using the Crab took place on 13 – 14 April involving *INTEGRAL*, *AstroSat* Insight-HXMT, *NICER NuSTAR Swift*, *XMM–Newton*, as well as radio and optical telescopes.

The *INTEGRAL* 16th Announcement of Opportunity (AO-16) call for observing proposals opened on 5 March, including the opportunity to propose for coordinated observations with *XMM–Newton*, *NuSTAR* and *Swift*. The call closed on 13 April, 14:00 CEST. Following a recommendation by the IUG, the time allocated for ToO observations was increased from 2 to 3 Ms. The number of proposals (62) decreased slightly compared to last year (65) while the total requested observing time increased. The time oversubscription increased to 5.3 (versus 4.2 last year). About half of the proposals were for ToO observations, including multi-messenger (astro)physical events, e.g. Gravitational Wave events. The community has shown increased interest in coordinated observations with *XMM–Newton*, *Swift* and *NuSTAR* (23 proposals requested coordinated time). The ISOC is preparing for the AO-16 TAC meeting on 29 – 31 May.

Scientific observations of the AO-14 and AO-15 cycle have been performed mostly as planned. In addition, a number of unsolicited, out-of-cycle Target-of-Opportunity (ToO) observations took place during this reporting period: CXOU J164710.2-455216 (7-11 Feb), Swift J1658.2-4242 (20-22 Feb, 11 & 27-29 Mar), MAXI J1813-095 (23 Feb), IGR J17379-3747 (1 Apr), and ASASSN-18fv (starting 23 Apr, see below). Another new black-hole X-ray binary transient (MAXI J1820+070) was detected by MAXI on 11 March which triggered an accepted ToO proposal (PI: Belloni). As a service to the community, the ISDC is providing ready-to-use lightcurves of this source. All the above ToO observations are public, and most of them were coordinated with other observatories like *XMM–Newton*, *NICER NuSTAR* and Swift.

On 13 August 2017, *INTEGRAL* discovered a new faint source, IGR J17329-2731, towards the the Galactic Center. The observations revealed that the source was a strongly magnetized ($\sim 10^{12}$ G) and slowly rotating ($\sim$6700 s) neutron star that had just begun to accrete from the wind of a low mass red giant. This makes IGR J17329-2731 a new member of the rare class of symbiotic X-ray binaries. IGR J17329-2731 is the first transient symbiotic X-ray binary which appeared as a newly born system of this class becoming a persistent source in our Milky Way (Bozzo et al. 2018, A&A, in press, arXiv:1803.01593). This result was featured in an ESA press release on 5 March, alarmingly entitled "Donor star breathes life into zombie companion".

On 20 March a new bright optical transient near the Galactic plane, ASASSN-18fv, was found by the All Sky Automated Survey for SuperNovae (ASAS-SN). ASASSN-18fv may be a Galactic nova, and if so it might show line emission from a ^{7}Be at 478 keV, making it a very interesting target for *INTEGRAL*. In consultation with the TAC and IUG it was decided to start an out-of-cycle observation as soon as possible after the ToO trigger. Results from these observations are highly anticipated.

The 12th *INTEGRAL* Conference – "*INTEGRAL* looks AHEAD to Multi-Messenger Astrophysics" – will be held in Geneva at the Campus Biotech from 11-14 February 2019, and will be organized by ISDC together with the AHEAD project (Integrated Activities in the High Energy Astrophysics Domain).

CALET

JOHN WEFEL (LSU)

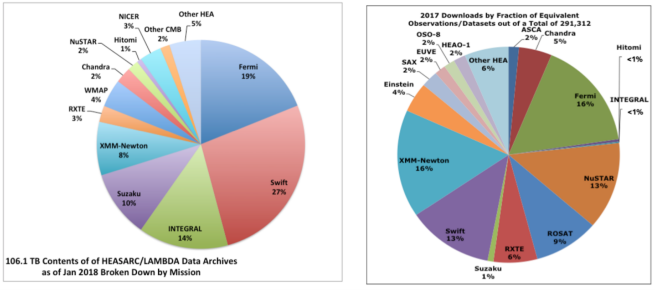
The CALorimetric Electron Telescope (*CALET*) on the

International Space Station continues to operate flawlessly, providing excellent data on high energy cosmic rays and gamma rays. The first total electron (electrons + positrons) spectrum was published in PRL in November, 2017 about the time of the HEAD fall newsletter. Since then, the *CALET* team has been able to relax some of the geometry cuts which opened the acceptance. Now, with about a factor of two more data, a revised total electron spectrum has been produced which also extends the energy range well beyond 1 TeV. This new result is currently under review for publication. Work on the other *CALET* science objectives, e.g. nuclei spectra, gamma rays, is progressing well, with publications expected in the near future. In addition, the *CALET* Gamma-ray Burst Monitor continues to add to the database of burst events, and participates in the search for counterparts to gravitational wave observations as well as high energy neutrino events.

The High Energy Astrophysics Science Archive Research Center

LORELLA ANGELINI & ALAN SMALE (NASA/GSFC)

The HEASARC continues to support the high-energy community by archiving data from the currently operating missions (*Swift*, *XMM–Newton*, *INTEGRAL*, *Fermi*, *Chandra*, *NuSTAR* and *NICER*) and past missions, by providing mission specific and multi-mission software (the latest HEASoft release was v.6.24, in Apr 2018), by providing updated calibration data through the CALDB (CALibration DataBase), and by providing multiple means to access the data and analysis software.



Left: HEASARC/LAMBDA data holdings color coded by mission as for Jan 2018. Right: Data downloads color coded by mission for the year 2017. Credit: HEASARC

In January 2018, the HEASARC data holdings exceeded the 100 TB milestone for the first time. The HEASARC archive includes, with few exceptions, data from the entire history of high-energy space-based missions and instrumentation which had state-of-art capabilities at the time they were flown. While the largest ("popular") data requests are for data obtained by currently operating missions, there is still a significant interest in data from legacy missions flown in the last century. These data are unique and valuable because of their unique instrumental capabilities and/or energy coverage (often unmatched by later missions), and/or because they happened to observe interesting sources at interesting times.

The latest additions to the HEASARC archive are the *Hitomi* data, made public on 30 October 2017 from both the HEASARC and DARTS/JAXA archives, and data from the *NICER* mission, which were publicly released on 8 March 2018. The *Hitomi* archive includes data processed with the most recent version of the software pipeline, as well as analysis software and calibration data. Detailed results from these data are now starting to appear in the literature. The *NICER* archive has been regularly populated with new observations, which appear after a two week validation period.

A recent major effort was the reprocessing of *Swift* data using the latest pipeline software and calibration data, and the release of these data to the *Swift* archive. This effort began in 2015, and at the time of this writing, reprocessed *Swift* data from almost the entire mission (except for the first month of *Swift* operations in December 2004) have "refreshed" the *Swift* archives at the HEASARC and in the UK and Italy.

Physics of the Cosmos News

T. J. BRANDT (NASA/GSFC, PCOS ACTING CHIEF SCIENTIST)

NASA's Physics of the Cosmos (PCOS) program explores some of the most fundamental questions regarding the physical forces and laws of the universe: from testing General Relativity to better understanding the behavior of matter and energy in extreme environments, the cosmological parameters governing inflation and the evolution of the universe, and the nature of dark matter and dark energy. To enable current and future missions to address these questions, the PCOS Program Office (PO) supports a number of community activities, including in facilitating 2020 Decadal Survey preparations, and reviews strategic technology capability gaps, prioritization, and development.

PCOS sessions at the AAS January and APS April meetings have included both exciting science results and forward-looking themes. Most talks are linked on our website, and we will continue to have remote connection so that you can participate even if you are not able to be physically present. Other articles in this newsletter include updates on the activities of our Science Interest Groups (SIGs), including X-ray, Gamma-ray, Cosmic Ray, and Gravitational Wave SIGs which met during the AAS and APS. We also supported the Gamma-ray and X-ray SIGs' splinter meetings and a Lynx special session at the HEAD 2020 conference that all provided community members another opportunity to get involved in planning for the future.

PCOS is providing support for community preparations for the 2020 Decadal Survey in several ways. One is by collecting your input! We would like to thank everyone who responded so quickly and thoughtfully to the recent

call for input about a possibly delay in the Decadal Survey. Decision-makers included your input in their decision to not delay the Decadal Survey. We remain open to hearing your thoughts as the Decadal process proceeds. See the Gamma-ray SIG, LISA, and X-ray SIG articles in this newsletter for more ways of giving input to science white papers!

Another activity we are excited about kicking off in June is the Multimessenger Astrophysics Science Analysis Group (MMA SAG). The MMA SAG will analyze the potential scientific benefits of multimessenger observations made possible by NASA observatories in the 2020s and beyond, both working in conjunction with each other and with other ground- and space-based instruments. This roughly one-year activity is completely open to anyone who wishes to participate, and we are hoping that you do! Check the MMA SAG website for details about the kickoff telecon June 8 and ways to contribute.

We welcome your input on PCOS science topics, particularly through the relevant PhysPAG Science Interest Groups, and by submitting technology gaps by June. We also look forward to seeing you either in person or virtually at our upcoming meetings and encourage you to join our email list and/or check our website for news. We will also be looking for new PhysPAG Executive Committee members for 2019! Feel free to talk with the current members or the PCOS Acting Chief Scientist if you are interested or have questions!

The X-ray Science Interest Group

Ralph Kraft (CfA) and John Tomsick (UC Berkeley)

This is an exciting time for the US X-ray astronomy community. The development of two new, powerful X-ray observatories, the X-ray Astrophysics Recovery Mission (*XARM*) and the Imaging X-ray Polarimetry Experiment (*IXPE*), is well underway. *Arcus*, a mission that would perform high resolution grating spectroscopy, was one of the concepts approved for phase A study in the most recent MIDEX round. The Russian/German mission Spectrum-X Gamma is scheduled for launch in early 2019 and will perform an unprecedented survey of the X-ray sky from 0.1 to 100 keV. In the longer term, there will certainly be significant US interest and participation in the European *Athena* mission. *Chandra*, *XMM–Newton*, *Swift*, *NuSTAR* and *NICER* all continue to provide our community with fabulous data.

While there are many smaller X-ray missions on the horizon for the high energy community, the long term prognosis for larger missions is somewhat less clear. Much of our community is focused on developing mission concepts and scientific papers for the upcoming Decadal Review. The *Lynx* mission concept study has submitted the *Lynx* interim report to NASA HQ. and those interested are encouraged to read this report and send comments, criticisms, and suggestions to the *Lynx* Science and Technology Definition Team (STDT). Three of the NASA-funded Probe class mission concept studies relevant to the high-energy community are also in advanced stages and will be submitting reports to NASA HQ and to the Decadal Review. Beyond these funded concept studies, we encourage everyone in the high energy astrophysics community who is interested in and concerned about the long-term prospects of our field to consider turning ideas for mission concepts into white papers for submission to the Decadal Review. One only has to consider how WFIRST was endorsed in the last review!

The XRSIG has been busy over the past year with meetings at the 2017 HEAD meeting in Sun Valley (the eclipse was fantastic!), the 2018 AAS meeting in Washington, DC, and the 2018 special HEAD meeting on future missions in Chicago, IL. The next XRSIG meeting will be at the 2019 AAS meeting in Seattle, WA. Finally, one of us (R. Kraft) will be rotating off the XRSIG (and the PhysPAG) at the end of the year. There will be an opportunity to apply for membership to the PhysPAG this fall to serve a three-year term, and we encourage anyone who is interested in representing the X-ray astronomy community to NASA for future missions and instrumentation development to consider applying. If you are interested in keeping abreast of XRSIG activities, you can sign up to the XRSIG mailing list.

The Gamma-ray Science Interest Group

Sylvain Guiriec (The George Washington University & NASA/GSFC), Henric Krawczynski (Washington University, St. Louis), John Tomsick (UC Berkeley)

The Gamma-ray Science Interest Group (GammaSIG) has been working on organizing the community around the common future of high-energy astronomers and their multi-messenger/wavelength partners by providing opportunities for communication and discussion about gamma-ray-related science. We have done this through approximately monthly telecons and also by having special sessions at meetings. The special GammaSIG session at the HEAD meeting in Chicago was fully devoted to a discussion of plans for Decadal Survey White Papers (WPs), and the session at the APS meeting in Columbus also included a WP discussion. On 23 – 24 May, we organized a 2-day workshop at George Washington University where we had excellent discussions about the exciting future opportunities for gamma ray astrophysics. Plans are underway for another workshop in August. For more information, please visit our web page to sign up for our mailing list for future GammaSIG announcements.

The Cosmic Ray Science Interest Group

IGOR MOSKALENKO (STANFORD), JAMES BEATTY (OHIO STATE)

A major summer event, the 42nd COSPAR Scientific Assembly, is approaching. It will take place on 14 – 22 July, 2018 in Pasadena, California, USA. Among a number of sessions of interest to cosmic ray community, we have one session E1.5 (17 – 21 July) dedicated to the origins of cosmic rays. It covers the whole energy range from supra-thermal particles to UHECR, and will feature highlight talks from all major collaborations working in the field of astrophysics of cosmic rays and astroparticle physics.

A resolution of a century-long mystery of cosmic ray (CR) origin is probably around the corner. The CR spectrum spans a huge energy range, $10^8 - 10^{20}$ eV, that at the first glance appears as an almost featureless power-law, apart from two kinks (the "knee" at 3×10^{15} eV and the "ankle" at 10^{18} eV). CRs below the "knee", and possibly even up to the "ankle", are likely to be Galactic, presumably accelerated in supernova remnant (SNR) shocks and pulsars, while the higher energy particles are clearly extra-galactic in origin. The absence of more pronounced "footprints" of possible acceleration mechanisms and CR sources has been making this problem so difficult to solve. However, the modern satellite, balloon, and ground-based detectors uncover surprising features in the CR spectra challenging the models of CR acceleration and propagation. Spectacular recent discoveries of the breaks and excesses over conventional expectations in spectra of CR species and their isotopic composition, direct measurements of gamma-ray emission from a number of particle accelerators, new CR results at very-high and ultra-high energies, and new controversies and alternative theoretical models will be highlighted during this event. This session encourages presentations of new experimental approaches and theoretical analyses directed towards answering questions related to the origins of these cosmic messengers.

Confirmed solicited speakers of the E1.5 session include: Elena Amato (Obs. Arcetri, Italy); Veronica Bindi (U. Hawaii, USA); Roger Blandford (Stanford, USA); Jin Chang (Purple Mountain Obs., China); Alan Cummings (Caltech, USA); Yoann Genolini (ULB, Belgium); Jordan Goodman (UMD, USA); Peter Gorham (U. Hawaii, USA); Clancy James (ICRAR, Australia); Vernon Jones (NASA HQ, USA); Leonid Kuzmichev (Moscow State U., Russia); Richard Lingenfelter (UCSD, USA); Mikhail Malkov (UCSD, USA); Pier Marrocchesi (Siena, Italy); James Matthews (Louisiana State U., USA); Mattia Di Mauro (Stanford, USA); Richard Mewaldt (Caltech, USA); Angela Olinto (U. Chicago, USA); Rene Ong (UCLA, USA); Sergey Ostapchenko (Frankfurt, Germany); Daniel Parsons (MPI for Kernphysik, Heidelberg, Germany); Piergiorgio Picozza (U. Roma, Italy); Dmitry Podorozny (Moscow State U., Russia); Troy Porter (Stanford, USA); Vladimir Ptuskin (IZMIRAN, Russia); Pier Giorgio Rancoita (INFN Milano-Bicocca, Italy); Stefan Schael (RWTH Aachen, Germany); Pierre Sokolsky (U. Utah, USA); & Samuel Ting (MIT, USA). All members of the astrophysics community are invited to participate!

The E1.5 session "Origins of Cosmic Rays" is organized by Igor Moskalenko of Stanford (main scientific organizer), and Eun-Suk Seo of UMD (deputy organizer).

Spectrum Röntgen Gamma/eROSITA

A. MERLONI (MPE), M. PAVLINSKY (IKI), P. PREDEHL (MPE), S. SAZONOV (IKI)

At the beginning of April 2018, the last Flight Model (FM) subsystem of the SRG Navigator Platform, the "radiocomplex" downlink system was delivered to NPOL Lavochkin Association.

ART-XC and eROSITA related activities have been progressing according to plan. The telescopes' electrical tests with the platform are currently under way. Testing of the ART-XC onboard software together with the service systems of the spacecraft has been completed. Ground calibration of the spare mirror systems and detectors is continuing.

Between mid-May and mid-September, Electro-Radio, Thermal-Vacuum and Vibration tests of the spacecraft will be performed. The mechanical and electrical coupling of the fully integrated system with the Block-DM upper stage is planned for the end of September. Final packaging and transportation of SRG to Baykonour will happen in January 2019. Launch date is now fixed for the first week of April 2019.

The participants of the yearly German eROSITA Consortium Meeting, which took place at MPE, Garching on 23 – 26 April 2018. Credit: eROSITA.

In parallel, preparations are in full swing at the mission operations and science centers in Moscow and Garching. SRG will be operated by a Mission Operation Center at NPOL Lavochkin; in addition, IKI (the Institute for Space Research of the Russian Academy of Science) will host the SRG Science Data and Operation Centers on its premises in Moscow. Finally, the eROSITA Science

and Operation Center will be hosted at MPE in Garching, Germany. Current activities include dry runs and tests of the data flow, and simulation of mission operation procedures in the Calibration and Performance Verification early phases of the mission.

From 23 – 26 April, more than 100 scientists gathered in Garching for the yearly meeting of the German eROSITA consortium. Alongside discussions of the scientific working groups, a number of "highlight" talks given by guests and collaborators from all over the world outlined the rich potential of multi-wavelength studies of the eROSITA X-ray sky.

Athena: Revealing the Hot and Energetic Universe

KIRPAL NANDRA (MPE), DIDIER BARRET (IRAP), RANDALL SMITH (CfA), AND FRANCISCO J. CARRERA (IFCA, CSIC-UC) FOR THE *Athena* SCIENCE STUDY TEAM AND THE *Athena* COMMUNITY OFFICE

The *Athena* mission continues to progress through Phase A. January saw the completion of Status Review 1 (SR1) in which the Phase A work so far was examined. The scope of SR1 included the work of the spacecraft primes, and detailed analysis of the costs and schedule. The review marked the formal end of the initial Phase A1 industrial studies, however a short ($\sim$ 6 month) extension is envisaged. The Mission Formulation Review (MFR) which marks the end of Phase A is currently scheduled for Q4 2019, with mission adoption in Q4 2021. The implementation schedule is significantly less certain but is currently envisioned in 2030/31.

As far as the instruments are concerned, the focus at system level is currently on the definition of the interfaces to the science instrument module (SIM), responsibility which can then be transferred back from ESA to the Industrial Primes. The first major review of the instruments, the Instrument Preliminary Requirements Reviews (I-PRRs) are scheduled for Q4 2018. ESA also recently initiated a process to recognize the Athena instrument consortia formally. A full AO is likely to be deemed unnecessary in favour of a lighter process which avoids duplication with the I-PRR work. The formalization process is expected to be complete before the end of 2018.

The X-IFU Consortium meeting #7 was held at the Astroparticle and Cosmology Institute in Paris from March 19-24th. More than 140 X-IFU Consortium members, engineers and scientists gathered to discuss science, calibration, instrument sub-systems, calibration, science ground segment... During the plenary sessions, the baseline configuration of the X-IFU was presented in great details by the CNES project team. The baseline meets the top level performance requirements of the instrument, in terms of spectral resolution, field of view, count rate capabilities... while meeting the 30% margin requirements on the thermal budgets. This was achieved by assuming that the outer shell of the Dewar would be cooled to about 200 K and by revisiting the assumptions on the dissipation at 2K. The cryogenic chain is based on five 15 Pulse Tubes (PT), two 4K Joule-Thomson (JT), two 2K JT and a last stage sorption-ADR: this configuration is robust against the failure of one cooler at the various temperature stages. In parallel to the cryogenic chain optimization, the electrical and mechanical architectures, the subsystem interfaces and requirements have been consolidated through iterations with the procurement teams. A last round of optimization on some key components of the instrument, e.g. the transition edge sensors, is now being performed, in view of relaxing constraints on the overall system, keeping the performance as currently specified. Interfaces of the X-IFU with the Athena science instrument module (SIM) are now being studied, during dedicated ESA led Concurrent Design Facility sessions, supported by the X-IFU team. Specific issues and plans about the payload, the SIM are now discussed within the recently set-up Athena System Engineering Board, which includes in particular the X-IFU PI, the X-IFU project and system managers. The X-IFU baseline will be consolidated until the next X-IFU progress meeting which will be held at CNES on June 27-28th. It will then be the basis for the Instrument Preliminary Requirement Review (IPRR) currently planned to be held mid-December. For that same purpose, the work breakdown of the X-IFU Instrument Science Center, the X-IFU component of the Athena Science Ground Segment is also being consolidated with the Consortium partners interested in contributing.

In preparation of the consortium formalization by ESA, an additional four X-IFU co-investigators were recently appointed: S. Bandler (US), E. Costantini (NS), L. Duband (FR), K. Sato (JP). Four experienced scientists joined the X-IFU science advisory team : S. Ettori (IT), J. Kaastra (NL), P. Mazzotta (IT), A. Simionescu (NL) to strengthen the coverage of the hot universe science, which is driving some key X-IFU performance parameters.

In December 2017, the Athena Community Office (ACO) released the fourth issue of the Athena Community Newsletter. This issue contained a highlight contribution on the discovery of electromagnetic counterparts to gravitational waves, written by Eleonora Troja and Luigi Piro. Eleonora was deeply involved in the study of the GW170817 event, so she became one of our three Athena People in this newsletter. Her professional profile is now stored in the Athena web portal under Community/Biographies.

The ACO has joined again the International Day of Women and Girls in Science on February 11, 2018. This year we counted with the help of several members of the Athena community to prepare a short video with cardboard messages to inspire the future and present generations. You can see this video in our YouTube channel.

Recently, the ACO has collaborated in the management of the 2017 Call to join the Athena Community Working Groups and Topical Panels. The selection pro-

cess has finished, with the appointment of the 28 new members, for a total of 889 members worldwide.

You can keep up-to-date with Athena via the community website, or through Twitter (@athena2028) and Facebook. Urgent or important notifications are sent to the Athena Community through bimonthly Brief News emails.

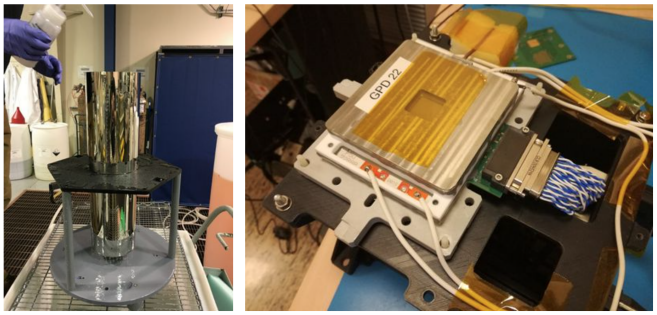
By the late 2020s and early 2030s there will be an assortment of major astronomical facilities working together across the electromagnetic spectrum (and beyond) in which Athena will figure prominently. The ASST has set out several synergy studies. The second such exercise has explored synergies between the Square Kilometer Array telescope and the Athena X-ray observatory mission, ranging from galaxy clusters and large-scale structure, and AGN and surveys to X-ray binaries, accretion physics and transient phenomena. A White Paper detailing these synergies will be published before Summer 2018. More exercises with optical/NIR surveyors and the gamma ray and multi-messenger facilities are in their initial stages.

Randall Smith gave a talk about Athena at the AAS 231 in Washington D.C. (8-12 January 2018). Paul Nandra gave an invited talk "Athena: ESA's next-generation X-ray observatory" at the HEAD Special meeting, "High Energy Astrophysics in the 2020's and Beyond" in Chicago (18-21 March 2018), in which he discussed the revolutionary characteristics of this mission. Etienne Pointecouteau presented the excellent capabilities for doing cluster science with Athena at the "Snowcluster: The physics of galaxy clusters" meeting in Utah (18 – 23 March 2018). The presentations are available from the meeting program webpage.

Imaging X-ray Polarimetry Explorer

M. C. Weisskopf, Brian Ramsey, & Steve O'Dell (NASA/MSFC)

Reviews, reviews, reviews. For IXPE, these past few months have been filled with reviews beginning with the Instrument (i.e. the polarization sensitive detectors and associated electronics) Preliminary Design Review (PDR) 5 – 7 March 2018 in Rome, followed by a spacecraft PDR (20 March) in Boulder, followed by a payload (everything that isn't spacecraft such as optics, detectors, etc.) PDR 24 – 26 April in Boulder. The Italian Space Agency held the Instrument Critical Design review on 14 – 16 May in Rome, which was successfully passes. Finally, the Mission PDR will be held in Boulder in June of this year. Needless to say, we are creating mounds of paper and, amazingly enough, some hardware. The figures show a mirror shell made from flight mandrels to be used in the mirror module assembly engineering unit and a test unit of the gas pixel detector built to flight specifications.



Left: Mirror shell made from flight mandrels to be used in the mirror module assembly engineering unit. Right: Gas Pixel Detector test unit. Credit:IXPE; NASA; ASI

The X-ray Astronomy Recovery Mission

Valerie Connaughton (NASA HQ), Rich Kelley (NASA/GSFC), & Rob Petre (NASA/GSFC)

Following a highly competitive peer-reviewed selection process, five US-based scientists will be joining the Japanese-led X-ray Astronomy Recovery Mission (XARM) as Participating Scientists. These scientists will become members of the US XARM Science Team and will contribute their expertise to the pre-launch science planning of the mission. They will be introduced to the rest of the XARM team later this month at the science kick-off meeting in Nara, Japan. The five Participating Scientists and their investigations are:

Lia Corrales, currently an Einstein Fellow at the University of Wisconsin, Madison. Dr. Corrales is a graduate of Harvey Mudd College and obtained her Ph.D. from Columbia University in 2014, where she held a NASA Earth and Space Sciences Fellowship (NESSF) grant. After postdoctoral stints at MIT and as an Einstein Fellow, she will begin a Collegiate Postdoctoral Fellowship at the University of Michigan Ann Arbor later this year, where she will perform her investigation "Interstellar dust grain mineralogy with high resolution spectra of dust scattering halos".

Erin Kara, a Hubble Fellow at the University of Maryland. Dr. Kara graduated from Barnard College and obtained her Ph.D. from Cambridge University (UK) in 2015 prior to becoming a Hubble Fellow. Her investigation "XARM observations of black hole accretion flows" will follow her transition from Hubble Fellow to faculty member at MIT in 2019.

Jon Miller, a professor at the University of Michigan, Ann Arbor where he will carry out his investigation "Revealing black hole outflows and inflows with XARM". He graduated from the University of Pennsylvania and obtained his Ph.D. from MIT in 2002. After three years as an NSF postdoctoral fellow at Harvard-Smithsonian CfA, Dr. Miller took up an assistant professor position at the

University of Michigan, where he became a full professor in 2015.

Paul Plucinsky, senior astrophysicist at the Smithsonian Astrophysical Observatory. A graduate of MIT, Dr. Plucinsky obtained his Ph.D. from the University of Wisconsin, Madison, in 1993, a position that included a two-year stint at Max-Planck Institut (MPE). He settled at SAO upon graduating and became Operations and Science Support Group Leader in 2015. His investigation into supernova remnants is called "XARM Resolve Spectra of 1E 0102.2-7219 and N132D".

Irina Zhuravleva, currently a postdoctoral fellow at Stanford University working with Steve Allen. After receiving her M.Sc. in St Petersburg, Russia, Dr. Zhuravleva obtained her Ph.D. in 2011 at Ludwig-Maximilian University and Max Planck Institute for Astrophysics in Germany, where she also spent one year as a postdoctoral fellow prior to coming to the Kavli Institute at Stanford in 2012. Her investigation "Gas dynamics in nearby galaxy clusters, groups and giant elliptical galaxies: velocity amplitude, anisotropy and power spectra" will be performed at NASA Goddard Space Flight Center where she has accepted a NASA Postdoctoral Program fellowship.

The Cherenkov Telescope Array

MEGAN GRUNEWALD (CTAO)

A prototype for the Cherenkov Telescope Array (CTA) under construction at the Whipple Observatory in Arizona, the Schwarzschild-Couder Telescope (pSCT), completed its primary mirror installation on 26 April 2018. The primary mirror consists of 48 mirror panel modules each including $\sim 1\text{m}^2$ aspheric mirror integrated with six actuators and four/five edge sensors for mirror positioning and alignment in the optical system of the telescope.

The prototype Schwarzschild-Couder Telescope (pSCT). Credit: CTA

"This event is very important milestone for the project, which pushes imaging atmospheric Cherenkov technology to the performance limit in the context of its future implementation in CTA," explains Vladimir Vassiliev, a professor of physics and astronomy at the University of California Los Angeles and the lead scientist for the pSCT project.

Now that the primary mirror is fully installed and its alignment system is being commissioned, the installation of the prototype SCT camera will begin in May and is expected to last through the middle of June. The installation of the secondary mirror, consisting of 24 mirror panel modules, is scheduled to begin in June and should be completed in early August. If all goes as planned, commissioning will begin in autumn 2018 when all the optical surfaces will be opened (the white film covering them during construction will be removed).

The SCT is a dual-mirrored version of the Medium-Sized Telescope (MST) that is proposed to cover the middle of CTA's energy range (80 GeV-50 TeV). The SCT's innovative two-mirror technology and the advanced high resolution camera is intended to capture the Cherenkov air showers at unprecedented imaging quality to significantly improve gamma-ray angular resolution of MST array in CTA and increase its sensitivity. In collaboration with CTA's 2-Mirror Small-Sized Telescope and Medium-Sized Telescope groups and institutes in Germany, Italy, Japan and Mexico, institutes in the United States have been the pioneers of the SCT design since 2006.

Follow the progress of the SCT prototype in Arizona live on its webcam. Visit the CTA website to learn more about CTA and to sign up for the CTA e-newsletter.

Lynx

DOUG SWARTZ (USRA & NASA/MSFC), JESSICA GASKIN (NASA/MSFC)

Lynx is the high-energy flagship mission concept funded for study by NASA for consideration in the next Astrophysics Decadal Survey. *Lynx* is a true next-generation X-ray observatory whose design will include excellent angular resolution, high throughput, large field of view, and high spectral resolution for both point-like and extended sources over the 0.1-10 keV bandpass. *Lynx* will provide unprecedented X-ray vision into the otherwise "Invisible" Universe with unique power to directly observe the dawn of supermassive black holes, reveal the drivers of galaxy formation, trace stellar activity including effects on planet habitability, and transform our knowledge of endpoints of stellar evolution.

The concept study is led by a Science and Technology Definition Team (STDT), drawn from interested community members, to formulate science and technology goals, the ensuing mission requirements, and a preliminary architecture for the mission concept. Following several milestones, the STDT will deliver a final report to NASA which NASA will submit to the Decadal Survey

Committee.

The major study milestone deliverables include the recently-completed Interim Report submitted in March 2018, a draft Final Report & Point Design Freeze currently slated for January 2019, followed by an independent cost estimate, and a Final Report (incorporating the ICE) to be submitted in the summer of 2019. The Interim Report provides the science case and mission concept for *Lynx* and delivers initial development plans for key technologies. NASA's Astrophysics Division, through the Decadal Studies Management Team, will use this Interim Report to document the study progress and to assess the path towards delivering the *Lynx* final report and producing the required deliverables while adhering to the study guidelines. The Interim Report will be reviewed by a Large-Mission Concept Studies Report Team. The LRT will provide a short written report and an out-brief to the STDT. The Interim Report will be made public following the LRT out-briefing.

Lynx STDT activities over the reporting period include the 4th STDT face-to-face meeting held 25-26 January 2018 in Houston, TX. Presentations and activities at this meeting included a detailed status report by the *Lynx* engineering team from MSFC, an in-depth introduction to mission cost methodology with preliminary cost estimates for *Lynx*, resolving instrument requirements flow-down from science goals, and strategic discussions of mission architecture and cost goals.

Other recent study-related highlights include the *Chandra* to *Lynx* workshop held 8 – 10 August 2017 in Cambridge, MA, designed to leverage *Chandra*'s legacy and maximize its impact on the development of *Lynx* science and design objectives. The meeting was attended by 110 scientists. The *Lynx* Study Office also provided visual presentations at the recent AAS winter meeting including an oral contribution to the session on NASA Decadal Preparations There were also presentations by the STDT co-chairs, the chair of the *Lynx* Instrument Working Group, and by the *Lynx* Study Scientist at the AAS High Energy Astrophysics Division special meeting held 18 – 21 March 2018 in Chicago, IL.

A *Lynx* Mirror Assembly Trade Working Group has been chartered by the *Lynx* STDT to recommend to the *Lynx* STDT Chairs by mid-summer one design reference mission concept Mirror Optical Assembly architecture to focus the design for the final report and identify any feasible alternates. Three X-ray optics designs have been identified as capable of meeting the *Lynx* requirements. These are Silicon Meta-shell Optics that use precision-polished monocrystalline silicon segments interlocked and bonded onto a central structural shell (being developed at NASA's Goddard Space Flight Center), Adjustable Segmented Optics that utilize low-voltage piezo actuators to induce in-plane stress for figure error correction of thin slumped-glass segmented mirror elements in a modular construction (Smithsonian Astrophysics Observatory), and Full-Shell Optics that use directly fabricated, polished, and passively figure-corrected full-circumference mirror shells (NASA's Marshall Space Flight Center and INAF's Brera Astronomical Observatory in Italy). The *Lynx* team, including an engineering contingent at MSFC's Advanced Concepts Office, will use the recommended Mirror Optical Assembly architecture to further refine the overall *Lynx* observatory design, program schedule, and cost analysis.

AstroPoetry Corner

(... A cautionary take on astronomical presentations. And this was before Powerpoint.)

When I Heard the Learn'd Astronomer

When I heard the learn'd astronomer,
When the proofs, the figures, were ranged in columns before me,
When I was shown the charts and diagrams, to add, divide, and measure them,
When I sitting heard the astronomer where he lectured with much applause in the lecture-room,
How soon unaccountable I became tired, and sick,
Till rising and gliding out I wander'd off by myself,
In the mystical moist night-air, and from time to time,
Look'd up in perfect silence at the stars.

— *Walt Whitman, Leaves of Grass, 1865*