National Aeronautics and Space Administration

Physics of the Cosmos Newsletter

August 2014 Vol. 4 No. 2

Summer 2014 PCOS Update

Mansoor Ahmed, *PCOS Program Manager*
Ann Hornschemeier, *PCOS Program Chief Scientist*

Since February 2014, progress has continued on a number of fronts in the PCOS portfolio. Chief among these are the next steps in defining a U.S. role in the European Space Agency (ESA) L2 and L3 opportunities. Following the June 2014 announcement by ESA of the selection of the L2 mission Athena we are now referring to this mission by name and are pleased to have selected, via an open community call in early July 2014, a U.S. representative to the Athena Science Study Team (SST). Please read Robert Petre's article on Athena which includes the full list of members of the ESA-selected SST. Conversations with ESA concerning L3 are at a much earlier stage and we ex-

(continued on page 2)

Contents

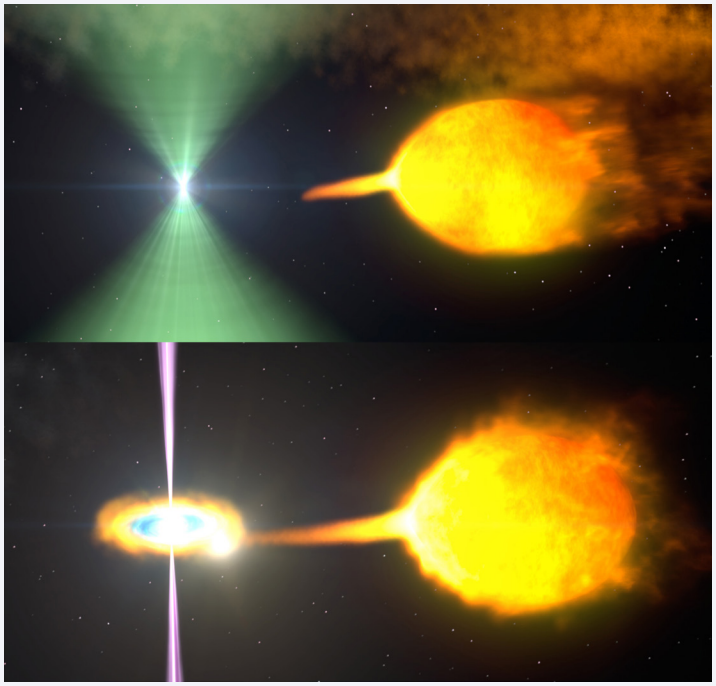
NASA's Fermi Finds A "Transformer" Pulsar

In late June 2013, an exceptional binary containing a rapidly spinning neutron star underwent a dramatic change in behavior never before observed. The pulsar's radio beacon vanished, while at the same time the system brightened fivefold in gamma rays, the most powerful form of light, according to measurements by NASA's Fermi Gamma-ray Space Telescope.

The binary pairs a 1.7-millisecond pulsar named PSR J1023+0038—J1023 for short—with a star containing about one-fifth the mass of the sun. The stars complete an orbit in only 4.8 hours, which places them so close together that the pulsar will gradually evaporate its companion.

For J1023, the dramatic changes seem to reflect an erratic interaction with its companion star, according to a recent study by an international team led by Ben Stappers at the University of Manchester in England.

The stars are close enough that a stream of gas flows from the sun-like star toward the pulsar. The pulsar's rapid rotation and intense magnetic field are responsible for both the radio beam and a powerful outflow of high-energy particles. When the radio beam is detectable, the pulsar wind blows back the companion's gas stream, preventing it from approaching too closely. But when the flow from the companion surges, the gas is able to reach toward the pulsar and establish an accretion disk.



These artist's renderings show one model of pulsar J1023 before (top) and after (bottom) its radio beacon (green) vanished. Normally, the pulsar's wind staves off the companion's gas stream. When the stream surges, an accretion disk forms and gamma-ray particle jets (magenta) obscure the radio beam. Image Credit: NASA's Goddard Space Flight Center

Gas in the disk becomes compressed and heated, reaching temperatures hot enough to emit X-rays. Next, material along the inner edge of the disk quickly loses orbital energy and descends toward the pulsar. When it falls to an altitude of about 50 miles (80 km), processes involved in creating the radio beam are either shut down or, more likely, obscured.

Read the full article at **http://www.nasa.gov/content/goddard/nasas-fermi-finds-a-transformer-pulsar/** and published paper **Stappers et al. ApJ, Vol. 790, p. 39** at **http://adsabs.harvard.edu/abs/2014ApJ...790...39S**

Chandra and XMM-Newton Provide Direct Measurement of Distant Black Hole's Spin

Black holes are defined by just two simple characteristics: mass and spin. While astronomers have long been able to measure black hole masses very effectively, determining their spins has been much more difficult.

Rubens Reis of the University of Michigan in Ann Arbor and his colleagues determined the spin of the supermassive black hole that is pulling in surrounding gas, producing an extremely luminous quasar known as RX J1131-1231 (RX J1131 for short). Gravitational lensing, first predicted by Einstein, offers a rare opportunity to study the innermost region in distant quasars by acting as a natural telescope and magnifying the light from these sources.

"Because of this gravitational lens, we were able to get very detailed information on the X-ray spectrum—that is, the amount of X-rays seen at different energies—from RX J1131," said co-author Mark Reynolds also of Michigan. "This in turn allowed us to get a very accurate value for how fast the black hole is spinning."

By measuring the spin of distant black holes researchers discover important clues about how these objects grow over time. The discovery that space-time at the black hole's event horizon is spinning at over half the speed of light suggests that RX J1131, observed at a distance of 6 billion light years, corresponding to an age about 7.7 billion years after the Big Bang, has grown via mergers, rather than pulling material in from different directions. Read the full article at **http://chandra.harvard.edu/press/14_releases/press_030514.html** and published paper **Reis et al. Nature Vol. 507, p. 207** at **http://adsabs.harvard.edu/abs/2014Natur.507..207R**

Gravitational lensing by an intervening elliptical galaxy has created four different images of the quasar, RX J1131-1231, shown by the Chandra data in pink; the Hubble data in red, green and blue shows the elliptical galaxy in the middle of the image, along with other galaxies in the field. The quasar is produced by a supermassive black hole six billion light years from Earth that is spinning extremely rapidly. This first direct measurement of the spin of such a distant black hole is an important advance for understanding how black holes grow over time. Image credit: X-ray: NASA/CXC/Univ of Michigan/ R.C.Reis et al; Optical: NASA/STScI

pect to give more updates in future newsletters. However, in the area of gravitational waves we are very excited to be able to say that we are now within one year of launching LISA Pathfinder, which is still on track for a July 31, 2015 launch. **Please read Ira Thorpe's update**. After all this time, we think it is fitting that we ended up with a 2015 LISA Pathfinder launch as this is the one hundredth anniversary of Einstein's paper on general relativity (GR). For the Centennial of GR, PCOS is actively involved in events/sessions planned at the January 2015 American Astronomical Society (AAS) meeting in Seattle working with AAS High Energy Astrophysics Division (HEAD) and at the April 2015 American Physical Society (APS) meeting in Baltimore working with APS's Topical Group in Gravitation (GGR) and Division of Astrophysics (DAP). We will also have other PCOS activities at those meetings; announcements are made via our **website** and **PCOS-News** email listserv.

Progress continues towards the 2020 launch of ESA's Euclid mission. Since the last newsletter NASA has become involved in Euclid's Science Ground Segment via the Euclid NASA Science Center at IPAC (ENSCI). Please **consult Jason Rhodes' article** for more information.

Our missions continue to operate well. We have press releases in this newsletter from three of our four PCOS missions (Chandra, XMM-Newton, and Fermi). Our fourth mission, Planck, has ceased operations, but data analysis is ongoing. A major press/data release is expected from Planck in October 2014 that will include polarization results; this is of course of even greater interest given the exciting spring 2014 BICEP2 results on a possible detection of primordial gravitational waves via the B-mode polarization of the Cosmic Microwave Background. **Fermi has discovered a pulsar that is evaporating its companion star**; **Chandra, working with XMM-Newton, has broken a distance record by measuring the spin of a supermassive black hole** (at z=0.658, a look-back time of 6 billion years); and **XMM has discovered mysterious X-ray pulsations in normal stars**.

We were pleased, but not surprised, to see PCOS and PCOS-related missions doing so well in the recent Senior Review. Swift, NuSTAR, XMM-Newton, and Fermi swept spots #1–#4 and all four are PCOS-related or PCOS missions. Chandra also received an excellent review (note that this year two of the Great Observatories, Hubble and Chandra, were reviewed separately from the other missions, while Spitzer was included with the others).

Within the PCOS program office during summer 2014 we are refreshing the technology gap list. You should look forward to the upcoming 2014 Program Annual Technology Report

(continued on page 3)

(PATR) for this refreshed technology gap list which was a result of a community call and input through the PhysPAG Executive Committee (EC) **(http://pcos.gsfc.nasa.gov/technology/tech-gap.php)**. Please read **John Nousek's PhysPAG article** for more information on what your Program Analysis Group has been up to recently.

We look forward to seeing you at the upcoming **HEAD, AAS, and APS meetings and at other venues where PCOS is present**. Please don't hesitate to **contact us with your questions/comments/concerns**.

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LISA Pathfinder Approaches Launch

Ira Thorpe, *NASA/GSFC*

Enthusiasts of space-based gravitational wave detectors are eagerly awaiting the launch of the LISA Pathfinder (LPF) mission, now less than a year away. LPF is an ESA-led technology demonstrator mission that will validate key technologies for a future LISA-like gravitational wave observatory. All flight components for both the European science payload, known as the LISA Technology Package (LTP), and the NASA science payload, known as the Space Technology 7 Disturbance Reduction System (ST7-DRS), have been delivered and are undergoing integration. The final flight component for the spacecraft bus, a cold-gas thruster based on the successful GAIA design, will be delivered later this year. Current focus is on completing integration of the science payload and preparation for operations and data analysis. After a launch in Summer 2015, LPF will take approximately 90 days to reach its operational orbit around the Earth-Sun Lagrange point (L1), where it will begin science operations. After 90 days of LTP operations followed by 90 days of DRS operations, LPF will have completed its prime mission.

In parallel to the LPF effort, the international space-based gravitational wave community continues to pursue a vigorous research program dedicated to bringing a full-scale observatory to fruition. This includes technology development efforts in the laboratory, implementation of the Laser Ranging Instrument on GRACE Follow On, development of data analysis tools and techniques for extracting astrophysical information from gravitational wave signals, concept design and science performance assessment for potential missions, and further de-

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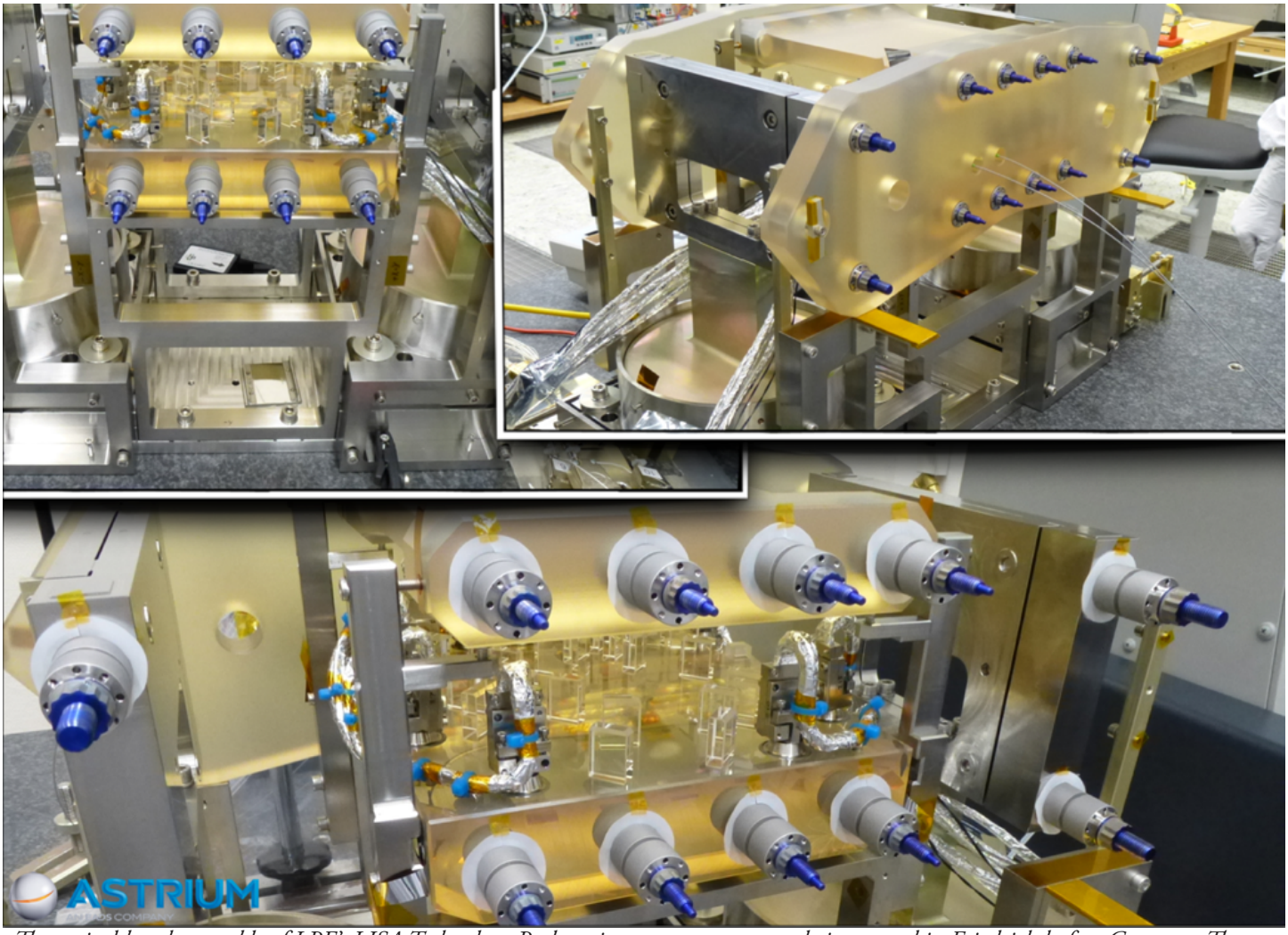

The optical bench assembly of LPF's LISA Technology Package instrument was recently integrated in Friedrichshafen, Germany. The optical bench will generate and measure interference fringes between various laser beams, allowing the position of the two inertial test masses to be measured with picometer precision

velopment of the rich science case for space-based detectors in the millihertz band. More than one hundred members of the community gathered in Gainesville, Florida for the 10th Annual LISA Symposium May 18–23, 2014, to share their research and foster collaboration. This is a testament to the compelling nature of the research and the continued strength of the science case for a LISA-like mission. Anyone interested in joining this effort should contact the eLISA consortium (**www.elisascience.org**).

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Physics of the Cosmos Program Analysis Group (PhysPAG) Report

John Nousek, *Chair of the PhysPAG Executive Committee*

The PhysPAG's 2014 activities have centered on gathering community feedback at the SIG (Science Interest Group) level concerning NASA Headquarters decisions and opportunities. These fall into two categories: responses to NASA's partnering efforts to achieve the Decadal Survey goals, and responses to budgetary decisions resulting in cuts to Astrophysics programs of interest for the PCOS Program.

On the partnering side, the U.S. is participating as a partner in Euclid, providing the detectors and related electronics, and membership in the Euclid Consortium. Euclid is a PCOS mission in formulation. NASA is also talking to ESA about possible collaborations for the L2 and L3 missions (see HQ column).

Important results have also led to opportunities for community response, such as the recent BICEP2 results on primordial polarization. Inflationary Probe Science Interest Group (IPSIG) members are working on a white paper that would put the measurements in a broader context and identify a path forward.

The GammaSIG has been sharing ideas with the AstroMeV consortium as part of an effort to develop future priorities for the field. Further discussions are expected to take place at the INTEGRAL workshop in September in Annapolis.

All of these opportunities will be discussed at the upcoming HEAD PhysPAG/PCOS Town Hall in Chicago in August 2014. Sessions at the April APS meeting, and future topical conferences will have SIG meetings to allow for community comment and input.

The final 2015 NASA budget is not complete, but the PhysPAG stands ready to provide feedback on the impact to the PCOS program.

The PhysPAG and related SIGs have worked with the Technology Development Manager, Thai Pham, to collect suggestions for technology support that coordinates with the needs of the NASA Astrophysics Implementation Plan. These "Technology Gaps" were captured in 21 submissions to PCOS.

Please don't hesitate to contact me, Jamie Bock (upcoming PhysPAG Chair), or any member of the Executive Committee on any matter of concern related to the PhysPAG, PCOS, or the Astrophysics Subcommittee. Our function is to solicit and coordinate community input to NASA's Science Mission Directorate, and that function is best served by an active engagement in the interests of the community.

If you are interested in serving on the PhysPAG EC, please stay tuned. Headquarters (HQ) will issue more information in the Fall.

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U.S. Participation in Athena

Robert Petre, *NASA/GSFC*

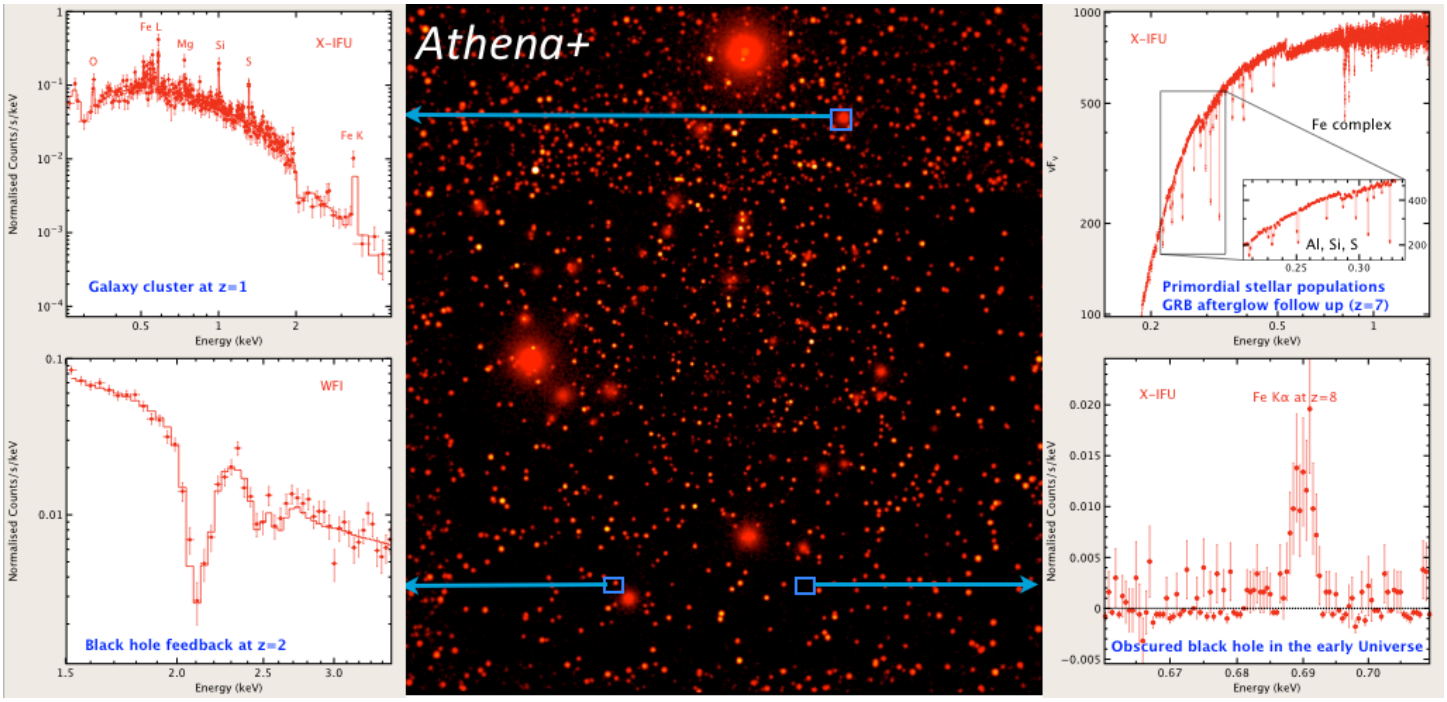
On June 27, ESA announced the selection of Athena (**http://www.cosmos.esa.int/web/athena**) as the second Large-class mission (L2) in its "Cosmic Vision 2015–25" program, which is described in more detail here: **http://www.esa.int/Our_Activities/Space_Science/Athena_to_study_the_hot_and_energetic_Universe**

Athena, to be launched in 2028, addresses the theme for L2, "The Hot and Energetic Universe." Athena is an X-ray observatory, addressing key questions in astrophysics, including: "How and why does ordinary matter assemble into the galaxies and galactic clusters that we see today?" and "How do black holes grow and influence their surroundings?" Its instrumentation will include the largest X-ray mirror ever flown (effective

(continued on page 5)

Name	Affiliation	Expertise	Term Expiration Date
J. Nousek, Chair	Penn State Univ.	X-rays	January 2015 *
J. Bookbinder	SAO	X-rays	December 2015
M. Bautz	MIT	X-rays	December 2016
S. Hanany	Univ. of Minnesota	CMB, Suborbital	December 2014
J. Bock	Caltech/JPL	CMB, Suborbital	December 2016
G. Mueller	Univ. of Florida	Gravitational Waves	December 2014
N. Cornish	Montana State Univ.	Gravitational Waves	December 2016
J. Rhodes	JPL	Dark Energy	December 2014
R. Bean	Cornell	Dark Energy	December 2016
A. Olinto	Univ. of Chicago	Astroparticles	December 2015
Eun-Suk Seo	Univ. of Maryland	Astroparticles	December 2016
L. Hays	GSFC	Gamma-rays	December 2014
M. McConnell	Univ. of New Hampshire	Gamma-rays	December 2016

* Term to be extended one year as *ex officio* member until December 2015



Athena will provide revolutionary advances in our knowledge of the Hot and Energetic Universe. The central panel is a simulated deep WFI observation, while the four surrounding spectra (three taken with the calorimeter instrument the X-IFU and one with the WFI, note the labels) illustrate advances in different science areas, none of which are possible with current facilities. Image Credit: ***The Athena Team****. Additional information can be found in the following paper:* ***http://arxiv.org/pdf/1306.2307v1.pdf***

area of 2 m^2 at 1 keV and 0.25 m^2 at 6 keV, with 5 arcsec angular resolution), plus two selectable focal plane detectors: a Wide Field Imager (WFI) (active pixel sensor with 40 arcmin field of view) and an X-ray Inertial Field Unit (X-ray calorimeter with 2.5 eV spectral resolution and 5 arcmin field of view). It will be placed into an L2 halo orbit and have a five-year lifetime. Additional information about Athena can be found at **http://www.cosmos.esa.int/web/athena**.

Athena will now enter an Assessment Phase, culminating in early 2015 with the release of an Announcement of Opportunity for the focal plane instruments and the ground segment. ESA has formed a Science Study Team (SST) to guide the development of science requirements. NASA is seeking involvement in Athena through a potential hardware contribution. One U.S. scientist, Randall Smith of the Harvard-Smithsonian Center for Astrophysics, has been selected for the SST. The full membership of ESA's Athena SST is given in the box below (see **http://www.cosmos.esa.int/web/athena/science-study-team**).

ESA's Athena Science Study Team:

Xavier Barcons (IFCA, ES)
Didier Barret (IRAP, FR)
Anne Decourchelle (CEA Saclay, FR)
Jan-Willem den Herder (SRON, NL)
Andrew Fabian (Cambridge, UK)
Hironori Matsumoto (Nagoya U, JP)
Kirpal Nandra (MPE, DE)
Luigi Piro (INAF, IT)
Randall Smith (CfA, U.S.)
Richard Willingale (Leicester, UK)

ENSCI and the Role of NASA in Euclid

Jason Rhodes, *NASA/JPL*

ESA's Euclid mission is progressing toward an expected launch in 2020. Euclid is designed to map the dark universe (made up of dark matter and dark energy) using weak gravitational lensing and galaxy clustering. NASA will contribute 16 Teledyne H2RG near infrared detectors, along with associated electronics and cryogenic cables, to Euclid's Near Infrared Spectrometer and Photometer (NISP) instrument. NASA has also recently been approved to develop a role for the Euclid NASA Science Center at IPAC (ENSCI), a node in the Euclid's distributed "science ground segment" that will process the Euclid data and then serve it to the 1300+ member Euclid Consortium. ENSCI will support both the 50+ U.S. members of the Euclid Consortium and then the broader U.S. community, as the Eu-

(continued on page 6)

The logo for the Euclid Consortium

Photograph of participants taken during the annual Euclid Consortium in May 2014 in Marseilles, France

clid data will be made public after a short period of restricted rights while consortium scientists validate it for release. The U.S. members of the Euclid Consortium have been successfully integrated with our European colleagues and are playing important roles in developing the algorithms and techniques to optimally exploit Euclid's planned 15,000 square degree imaging and grism spectroscopy survey. Successful reviews of the Euclid visible (VIS) and near infrared (NISP) instruments in the past year are to be followed by similar reviews of Euclid's calibration plan and Science Ground Segment in the next year. The Euclid Consortium had its annual meeting in Marseilles France in May 2014 (see photo).

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Message from the NASA HQ Astrophysics Division Director

Paul Hertz, *Director, Astrophysics Division, NASA Science Mission Directorate*

As we approach the end of the 2014 fiscal year, it is time to reflect on our achievements and shortcomings, and plan for challenges ahead. We have been extremely fortunate that our space-based missions, both large and small, have continued to make headlines with spectacular scientific discoveries that capture the mind of the public. We have learnt more about the way the universe works, have studied the birth of stars and galaxies, and have made great strides in discovering and understanding exoplanets.

As I described during the NASA Town Hall at the American Astronomical Society meeting in Boston on June 2, 2014, we continue to make progress addressing the priorities of the 2010 Decadal Survey for Astronomy and Astrophysics. The appropriation that NASA Astrophysics received for FY 2014 and the Administration's FY 2015 budget request both support our plans for continued progress. The progress we are making toward the major recommendations of the 2010 Decadal Survey includes:

- A goal of the Astrophysics Division is to be prepared to start a new strategic NASA Astrophysics mission to follow JWST as soon as funding becomes available. Preformulation and focused technology development for a 2.4m version of the Wide-Field Infrared Survey Telescope (WFIRST), a mission concept referred to as the Astrophysics Focused Telescope Assets (AFTA), are underway. NASA received $56M in directed funding for in FY 2014 for WFIRST/AFTA to continue preformulation activities and technology development. A recent National Research Council (NRC) study on WFIRST/AFTA offers a positive view of WFIRST/AFTA in the context of the Decadal Survey with concerns about technology and cost risks. The Administration's FY 2015 budget request supports an Agency/Administration decision for formulation of WFIRST/AFTA to begin no earlier than FY 2017, should funding be available.
- A new ROSES element, WFIRST Preparatory Science, was announced on April 21, with a goal to bridge from basic theory to observational modeling for WFIRST/AFTA; and more than 50 proposals were received on July 11. Investigators selected will coordinate efforts with the WFIRST Study Office and the WFIRST/AFTA Science Definition Team.
- The Administration's FY 2015 budget request includes augmentation of the Explorer program to enable more frequent flight opportunities, including a planned SMEX AO later this year (see the draft AO at **http://nspires.nasaprs.com/** and the community announcement at **http://explorers.larc.nasa.gov/APSMEX/**) and a MIDEX around FY 2017.
- Strategic technology investments are being made and partnerships are being discussed with the ESA in their gravitational wave and X-ray observatories. NASA has joined ESA in supporting the ESA Science Study Team for the recently selected mission concept, "Advanced Telescope for High-ENergy Astrophysics" (Athena).
- Strategic technology investments are being made to advance the medium scale programs including technology

(continued on page 7)

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for exoplanet missions and technology for detection of polarization of the cosmic microwave background.
- Modest augmentations have been made to small programs including R&A.

The FY 2014 appropriation for NASA provides $658M for JWST and $668M for the rest of NASA astrophysics. The FY 2015 Administration's budget request would provide $645M for JWST and $607M for the rest of NASA astrophysics. Both budgets support the continued development of JWST on plan toward its launch in 2018, and both budgets include funding for continued preformulation of WFIRST as described above. Both budgets also includes funding for several new missions including the Transiting Exoplanet Survey Satellite (TESS), the next Astrophysics Explorer mission, the Neutron Star Interior Explorer (NICER), the next Astrophysics Explorer Mission of Opportunity, and the NASA contribution to ESA's Euclid mission.

The Administration's FY 2015 budget proposes to place SOFIA into storage by FY 2015 unless partners are able to support the U.S. portion of SOFIA costs. The NASA appropriation subcommittees in both houses of Congress, however, have proposed continued funding for SOFIA at a level sufficient to continue operations. NASA has continued to conduct the SOFIA program as planned during FY 2014.

Other program highlights since my last Newsletter include:
- SOFIA formally entered the Operations Phase in May. Second generation instruments, HAWC+ (U.S.), and upGREAT (German) are under development. In late June, SOFIA was flown to Germany for a Heavy Maintenance Visit.
- Astrophysics research funding remains flat, retaining the growth realized since the Decadal Survey, with the success rate of proposals hovering between 15%-24%. This is caused by a sharp increase in the number of proposals received.
- A Senior Review of operating missions was conducted in April. At that time, all operating missions other than Spitzer were approved for continued operation. The NEOWISE-R data analysis proposal, MaxWISE, was not approved for funding. A full report of the Senior Review may be found at **http://science.nasa.gov/astrophysics/2014-senior-review-operating-missions/**.
- In July, the Science Mission Directorate made the decision to extend Spitzer operations for the next two years. The Spitzer observatory is an important resource for ongoing infrared observations for research programs across the Science Mission Directorate, and, subject to the availability of Congressional appropriations in FY 2015, it will be continued.
- Astrophysics approved some funds for education activities in FY2014 and has continued a limited number of high impact activities.

Major activities planned for FY 2015 include confirmation of the TESS Explorer mission, launch of the ISS-CREAM experiment to the Space Station, Step 1 selection of the next Small Astrophysics Explorer and Explorer Mission of Opportunity Phase A studies, launch of ESA's LISA Pathfinder with NASA's ST-7, completion of the WFIRST/AFTA science definition team report, conduct of the Astrophysics Archives Senior Review, start of the NRC Mid-Decade Review, and celebration of twenty five years of operation of the Hubble Space Telescope. All Astrophysics programs flow from the recently completed NASA 2014 Science Plan, which is available at **http://science.nasa.gov/about-us/science-strategy/**.

My entire presentation to the American Astronomical Society meeting is available at **http://science.nasa.gov/astrophysics/documents/**.

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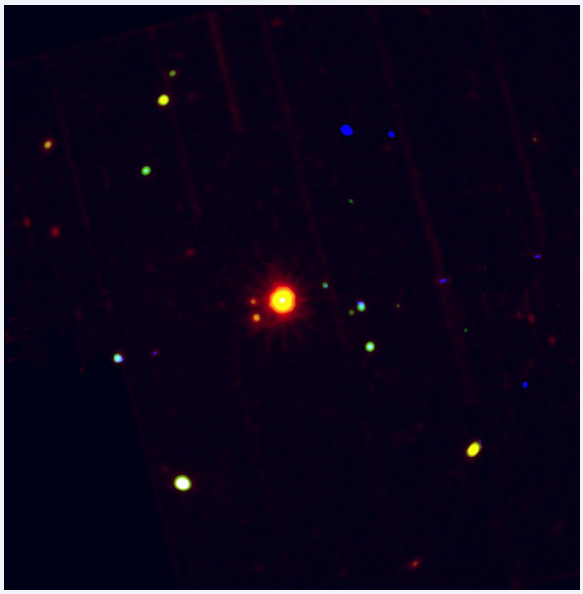
Pulsating X-rays allow XMM-Newton to unmask a mysterious star

Xi[1] Canis Majoris is an extremely bright star with a surface temperature of approximately 27,500 K, and a mass of approximately 15 times that of the Sun. This massive star has an immensely strong magnetic field, nearly 10 000 times stronger than Earth's and 5000 times stronger than the Sun's. The star's magnetic field is carried into space by the stellar wind—a river of particles flowing outward from the star.

The star shines brightly in X-rays, thought to be produced from shock waves in the star's magnetic field that accelerate the stellar wind particles.

Lidia Oskinova from University of Potsdam, Germany, led the study that uses XMM-Newton to observe Xi[1] Canis Majoris to search for clues about the process. Analyzing 29 hours of data from simultaneous observations of XMM-Newton's onboard RGS spectrograph and EPIC camera, the team discovered something unexpected. The star's X-ray emission pulsated, rising and falling in a regular, repeating fashion every 5 hours. Such pulsations have never before been seen from normal stars. "So far, we don't understand the physics behind these pulsations," says Oskinova.

"This is breakthrough science because it shows that X-ray pulsations can take place not only in exotic objects but in normal stars too. New physical processes governing stellar winds can now be studied. Also, it highlights both the capabilities of XMM-Newton and the long lasting legacy of the Hipparcos star mapper," says Norbert Schartel, ESA XMM-Newton Project Scientist. Read the full article at **http://sci.esa.int/xmm-newton/54101-pulsating-x-rays-allow-xmm-newton-to-unmask-a-mysterious-star/** and published paper **Oskinova et al., Nature Communications, vol 5, id 4024** at **http://www.nature.com/ncomms/2014/140603/ncomms5024/full/ncomms5024.html**



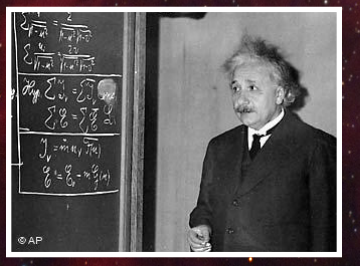
XMM-Newton has revealed a unique star. It is a celestial chimera with the body of a normal massive star yet the magnetic field of a dead, stellar dwarf. This makes it a singular object among the billions of known stars. This 3-colour image of the field (centered on Xi[1] CMa) was made by mapping 0.2–1.0 keV emission to red, 1.0–2.5 keV emission to green, and 2.5–10.0 keV emission to blue. Image Credit: ESA/XMM-Newton/L. Oskinova (University of Potsdam)

2015: The Centennial of General Relativity

PCOS will be participating in two upcoming events

(NOTE: Working titles, all speakers confirmed but talk titles are notional.)

- **Jan 5–8 American Astronomical Society meeting in Seattle, WA**
  - **Co-organized by Ann Hornschemeier and Chris Reynolds**
  - **Monday, January 5, 2015 10:00 AM**
    - **HEAD I: Centennial of General Relativity: An Astrophysical Perspective**
    - **Clifford Will, University of Florida, "Astrophysical Tests of General Relativity"**
    - **Charlie Misner, University of Maryland, "A Historical Perspective on relativity theory and black holes"**
    - **Virginia Trimble, UC Irving/UMd, "A Historical Perspective on High Energy Astrophysics and Constraints of General Relativity"**
  - **Monday, January 5, 2015 2:00 PM**
    - **HEAD II: Centennial of General Relativity: Looking Forward**
    - **Neil Cornish, Montana State, "Looking ahead to Space-based Measurements of Gravitational Waves"**
    - **Michael Kramer, Max Planck Institute for Radioastronomie, "Binary Pulsar Constraints on General Relativity"**
    - **Rachel Bean, Cornell University, "Testing General Relativity with Cosmology"**
  - **Organized by Gabriela Gonzalez**
  - **Wednesday, January 7, 2015, 2:00 PM:**
    The quest for gravitational waves, 100 years after Einstein
  - **We are also planning activities at the PCOS table in the NASA SMD area.**
- **April 5–8 American Physical Society meeting in Baltimore, MD**
  - **Stay tuned! Plans are in progress and include a PCOS booth.**



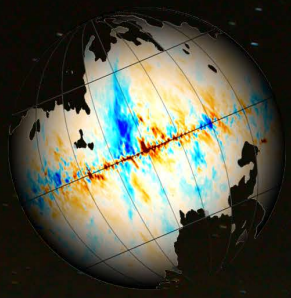
For updates please visit pcos.gsfc.nasa.gov and/or subscribe to the pcos-news email list

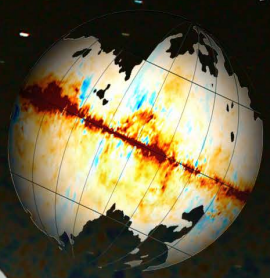
PLANCK 2014

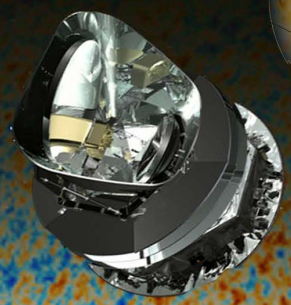
THE MICROWAVE SKY IN TEMPERATURE AND POLARIZATION

1-5 December 2014, Palazzo Costabili, Ferrara, Italy

NEW RESULTS FROM PLANCK AND OTHER EXPERIMENTS ON COSMOLOGY, FUNDAMENTAL PHYSICS, GALACTIC AND EXTRAGALACTIC ASTROPHYSICS, DATA ANALYSIS AND NEXT OBSERVATIONAL CHALLENGES







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Meet the Einstein Fellows: Tim Linden

Tim is currently involved in improving models of the astrophysical and dark matter signatures of the galactic center region, and on producing novel tests that are able to effectively separate dark matter from other astrophysical signatures.

In models where dark matter is composed of weakly interacting particles, the residual annihilations of dark matter particles are expected to provide one of the most convincing signatures of its particle properties. Models of dark matter structure formation indicate that the highest fluxes from dark matter annihilation are expected to be produced from the region surrounding the galactic center of the Milky Way. However, this region also contains extremely complex astrophysical sources, which act as foregrounds in searches for a dark matter particle.

Tim's recent work concentrates on gamma-ray observations from the Fermi-LAT telescope. In collaboration with other researchers, he has produced evidence indicating a bright feature in the galactic center with the spectral and morphological properties expected from a dark matter particle. Multiple tests are now underway by several teams in order to confirm and better understand this excess.

Tim completed his Ph.D at the University of California, Santa Cruz in 2013 and his undergraduate degree from Northwestern University in 2008. He is currently finishing his first-year as an Einstein Fellow in the Kavli Institute of Cosmological Physics at the University of Chicago.

Calendar of Upcoming PCOS/PhysPAG Events

Tuesday, August 19, 2014 12:30–1:30 PM	PCOS/PhysPAG Town Hall at the High Energy Astrophysics (HEAD) Meeting Chicago, Illinois
October 20–24, 2014	Fifth International Fermi Symposium Nagoya University, Nagoya, Japan
October 28–29, 2014	Einstein Fellows Symposium Center for Astrophysics, Cambridge, Massachusetts
November 2014	Fifteen Years of Chandra Meeting Center for Astrophysics, Cambridge, Massachusetts
December 1–5, 2014	Planck 2014: The microwave sky in temperature and polarization Palazzo Costabili, Ferrara, Italy
January 4–8, 2015	PhysPAG Meeting at the American Astronomical Society (AAS) Meeting Seattle, Washington
April 11–14, 2015	PCOS/PhysPAG Sessions at American Physical Society Meeting Baltimore, Maryland
June 8–10, 2015	XMM-Newton 2015 Science Workshop, Madrid, Spain

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