

High Energy Astrophysics and Cosmology from Space: NASA's Physics of the Cosmos Program

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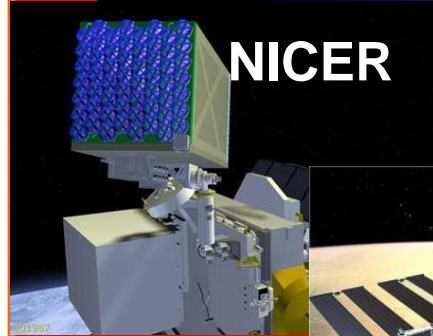
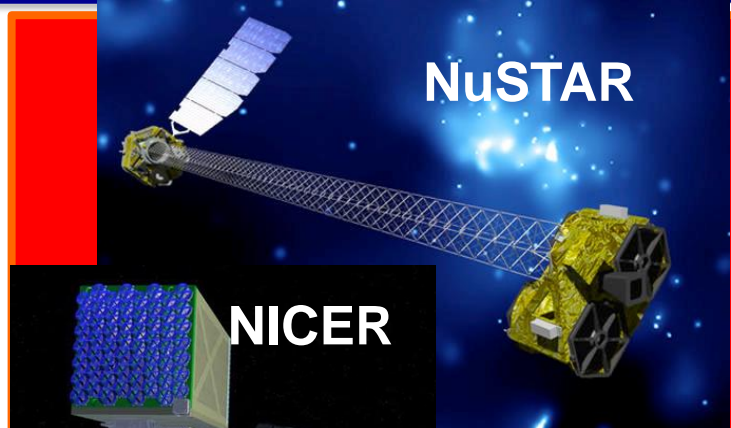
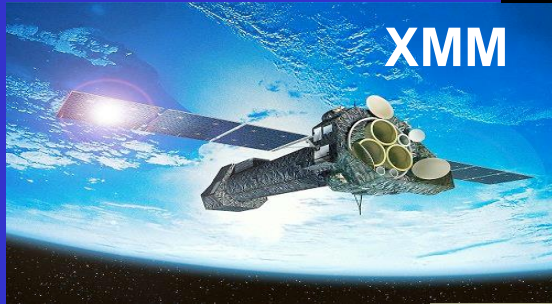
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OPERATING MISSIONS

PCOS

PCOS-RELATED



The near-future

PCOS Missions in Development

- Two of the six current developmental projects being prepared during FY17 for launch are in the PCOS portfolio: Euclid & IXPE

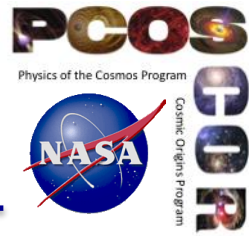


(PCOS program)



(PCOS-themed)

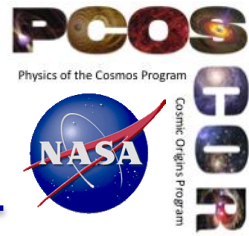
Large Mission Activities in PCOS: Athena, LISA, and Lynx



- **ESA Cosmic Vision program (2016-2035):**
 - Athena (L2, launch 2028) will be an X-ray mission following the Hot and Energetic Universe theme
 - LISA (L3, launch 2034) will be a gravitational wave observatory following the Gravitational Universe theme.
- **Athena is in Phase A (formulation) and LISA is preparing to enter Phase A with NASA participation**
- **Large mission studies in PCOS (preparation for 2020 Decadal)**
 - L3 Study Team → in transition to U.S. LISA Study Team
 - Lynx (formerly X-ray Surveyor) NASA Flagship Mission Study
- **After this talk: Neil Cornish (LISA) and Feryal Ozel (Lynx)**

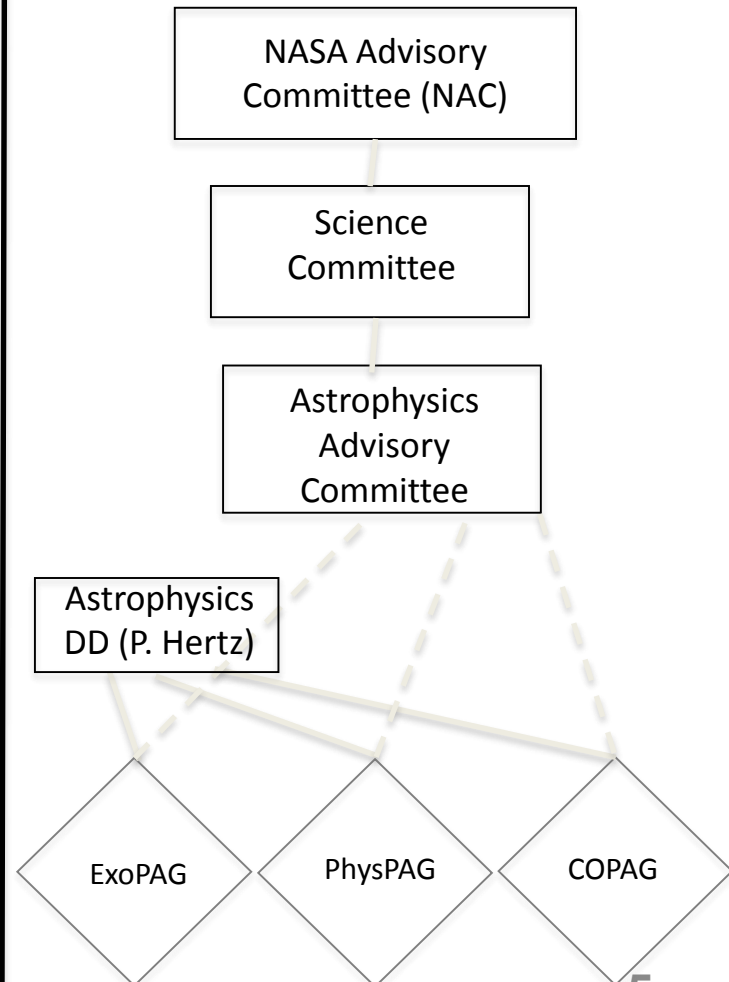
**How can you interact with NASA's
Physics of the Cosmos program?**

Communicating with NASA Astrophysics via the Program Analysis Groups (PAGs)



- The Physics of the Cosmos Program Analysis Group (PhysPAG) serves as a forum for soliciting and coordinating input and analysis from the scientific community in support of the PCOS program objectives.
- The Program Analysis Groups (PAGs) include all members of the community interested in providing input to NASA on issues of strategic importance via analysis studies
- PAGs hold regular public meetings.
- PAGs identify specific, well-defined topics for further detailed studies assigned to Study Analysis Groups (SAGs) as well as longer-standing, discipline-centered analysis groups – Science Interest Groups (SIGs). All are task forces of volunteers.

Advisory Committees



PhysPAG Executive Committee Membership

- Six SIGs in operation for the Inflation Probe, Gamma Rays, Cosmic Rays, Gravitational Waves, X-rays & Cosmic Structure
- **Applications due October 1, 2017**

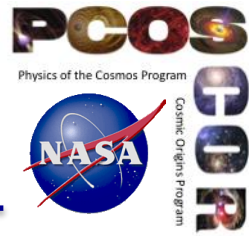
| Name | Affiliation | Area of Expertise | Term Ends |
|-------------------------|----------------------------------|-----------------------|----------------------------|
| M. Bautz, Chair | MIT | X-ray astrophysics | May 2018 |
| J. Conklin, Vice-Chair | Univ. of Florida | Gravitational Waves | May 2019 |
| Rachel Bean | Cornell Univ. | Dark Energy | December 2017 |
| Olivier Doré | JPL | Dark Energy | December 2017 |
| Henric Krawczynski | Washington Univ. in St. Louis | Gamma-rays | December 2017 |
| Amber Miller | USC | CMB | December 2017 |
| Ed Wollack | NASA/GSFC | CMB | December 2017 |
| Jim Beatty | Ohio State Univ. | Particle Astrophysics | December 2019 |
| Sylvain Guiriec | George Washington Univ. | Gamma-rays | December 2019 |
| Kelly Holley-Bockelmann | Vanderbilt Univ. | Gravitational Waves | December 2019 |
| Ralph Kraft | SAO | X-rays | December 2018 |
| Igor Moskalenko | Stanford | Particle Astrophysics | December 2018 |
| John Tomsick | UC Berkeley | X-rays and Gamma-rays | December 2019 ⁶ |

PCOS community activities

- Encourage your finishing students and early-career postdocs to apply for the Einstein fellows' program
 - Einstein Fellows hold their appointments at a Host Institution in the U.S. for research that is broadly related to the science goals of the NASA Physics of the Cosmos program.
- The PhysPAG provides input on technology needs to the PCOS program office that are fed into the PCOS Annual Technology Report (PATR) each year.



Krista Smith, 2017 Fellow



Keeping up with PCOS

- <http://pcos.gsfc.nasa.gov>
- View the latest newsletter.
- Sign up to the PCOS email list.
- Sign up to be included on SIG emails.
- Members of NASA PCOS Team include:
 - At GSFC:
 - Ann Hornschemeier
 - Terri Brandt
 - At HQ:
 - Rita Sambruna
 - Dan Evans
 - Thomas Hams

Physics of the Cosmos Newsletter

July 2016 Vol. 6 No. 1

Physics of the Cosmos Program Update
 Peter Bertone, *PCOS Program Deputy Chief Scientist*
 Ann Hornschemeier, *PCOS Program Chief Scientist*
 Mansoor Ahmed, *PCOS Program Manager*

Welcome to this special edition newsletter devoted to suborbital projects related to high energy astrophysics and cosmology under the Physics of the Cosmos (PCOS) science themes. We highlighted suborbital projects in our 2014 PCOS newsletter and plan to do this approximately every 2 years or so given that for many areas in PCOS there is a great amount of activity going

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NASA's Fermi Satellite Kicks Off a Blazar-detecting Bonanza

In April, 2015 NASA's Fermi Gamma-ray Space Telescope observed a flood of high-energy gamma rays from a blazar outburst, which helped two ground-based gamma-ray observatories detect some of the highest-energy light ever seen from a galaxy so distant. The observations provide a surprising look into the environment near a supermassive black hole at the galaxy's center and offer a glimpse into the state of the cosmos 7 billion years ago.

"When we looked at all the data from this event, from gamma rays to radio, we realized the measurements told us something we didn't expect about how the black hole produced this energy," said Jonathan Biteau at the Nuclear Physics Institute of Orsay, France.

Astronomers had assumed that light at different energies came from regions at different distances from the black hole. Gamma rays, the highest-energy form of light, were thought to be produced closest to the black hole. "Instead, the multiwavelength picture suggests that light at all wavelengths came from a single region located far away from the power source," Biteau explained.

The gamma rays came from a galaxy known as PKS 1441+25, a type of active galaxy called a blazar. At its heart lies a monster black hole with a mass estimated at 70 million times the sun's and a surrounding disk of hot gas and dust.

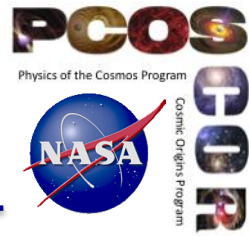
In April, PKS 1441+25 underwent a major eruption. Luigi Pacciani at the Italian National Institute for Astrophysics in Rome was leading a project to catch blazar flares in their earliest stages in collaboration with the Major Atmospheric Gamma-ray Imaging Cerenkov experiment (MAGIC), located on La Palma in the Canary Islands. Using public Fermi data, Pacciani discovered the outburst and immediately alerted the astronomical community. Fermi's Large Area Telescope revealed gamma rays up to 33 billion electron volts (GeV), reaching into the highest-energy part of the instrument's detection range. For comparison, visible light has energies between about 2 and 3 electron volts.

Read the full article: <http://www.nasa.gov/feature/goddard/nasas-fermi-satellite-kicks-off-a-blazar-detecting-bonanza>



Black-hole-powered galaxies called blazars are the most common sources detected by NASA's Fermi Gamma-ray Space Telescope. As matter falls toward the supermassive black hole at the galaxy's center, some of it is accelerated outward at nearly the speed of light along jets pointed in opposite directions. When one of the jets happens to be aimed in the direction of Earth, as illustrated here, the galaxy appears especially bright and is classified as a blazar. Credits: M. Weiss/CfA

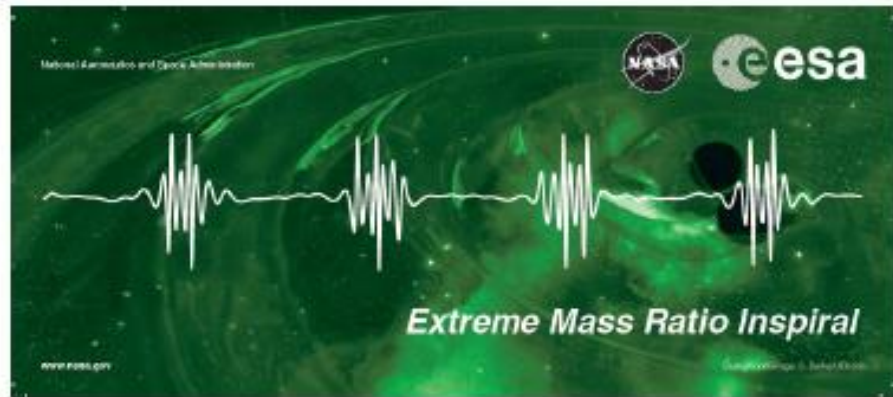
Upcoming PCOS/PhysPAG Community Interaction Opportunities



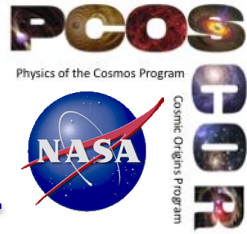
- **NASA's PCOS program and the PhysPAG have sessions/booths at:**
 - HEAD meetings (note table out the in hallway, get some bookmarks!)
 - XRSIG last night, GammaSIG – Thursday lunchtime, this town hall
 - January AAS meetings (next one: Washington, D.C.)
 - PhysPAG meeting and SIG sessions
 - April American Physical Society meetings (next one: Columbus, Ohio)
 - PCOS Mini-symposium
(~90 minutes of high energy astro & cosmology from space)
 - SIG sessions (Gravitational waves, Cosmic Rays, Gamma Rays)
- **MORE INFO: pcos.gsfc.nasa.gov/physpag**

Advocacy : we value your input!

- These came out of a conversation with the community, you might have the next great idea!



THANK YOU



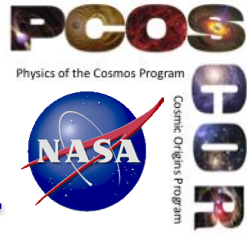
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(Sign up for email list at “PCOS News and Announcements tab)

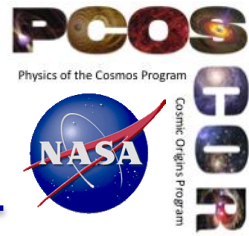
THANK YOU



BACK-UP SLIDES

Where does Physics live at NASA?

Prioritization from Astro2010 Decadal Report



Astro2010 science themes map to the Astrophysics Division themes:

New Worlds

Exoplanet Exploration

Cosmic Dawn

Cosmic Origins

Physics of the Universe



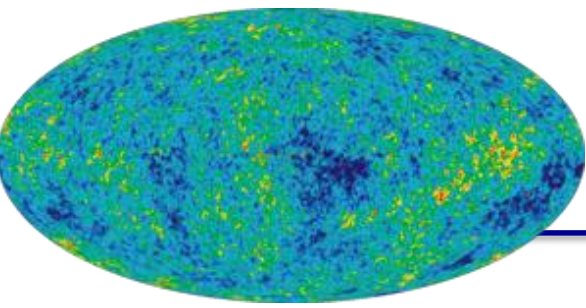
Physics of the Cosmos

The highest priority science for Physics of the Universe are captured in the PCOS Science Objectives:

Dark Energy: Probe the nature of dark energy by studying the expansion rate of the universe and the growth of structure

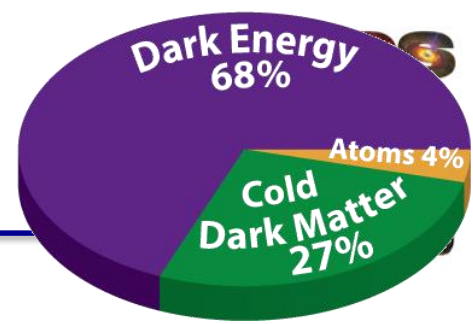
Theory of Inflation: Test the theory of inflation by measuring the polarization of the Cosmic Microwave Background.

Black Holes & General Relativity: Probe the properties of black holes and testing General Relativity using x-ray emission and gravitational waves.

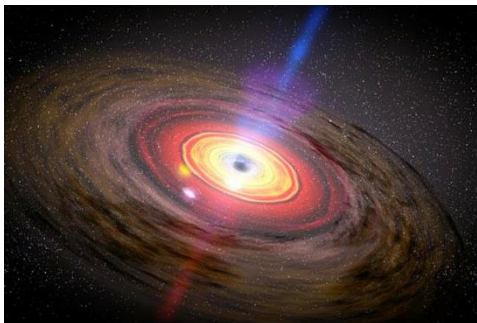
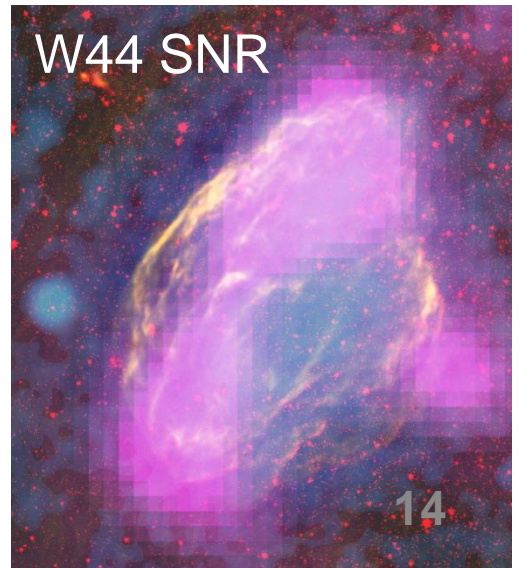
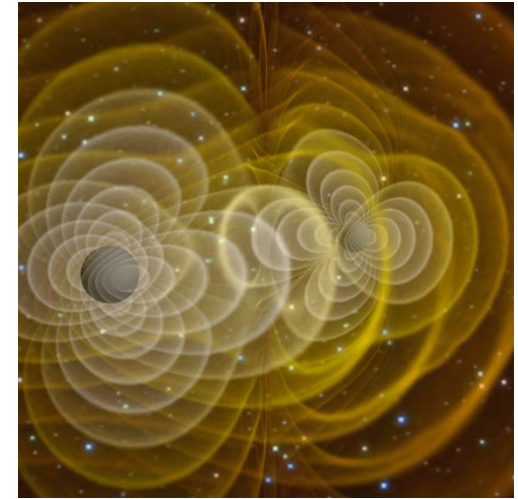


Physics of the Cosmos

Science Objectives

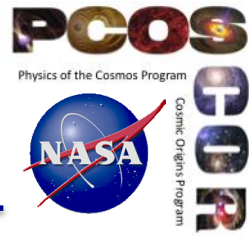


- Expand our knowledge of dark energy
- Precisely measure the cosmological parameters governing the evolution of the universe and test the inflation hypothesis of the Big Bang
- Test the validity of Einstein's General Theory of Relativity and investigate the nature of spacetime
- Understand the formation and growth of massive black holes and their role in the evolution of galaxies



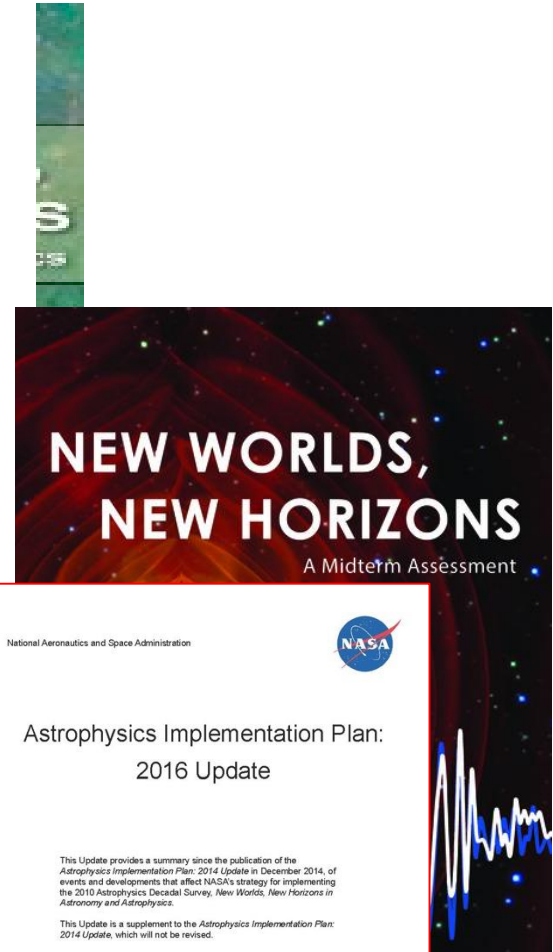
- Explore the behavior of matter and energy in its most extreme environments

Physics of the Cosmos (PCOS): Scientific and Technical Stewardship for future missions



Provide scientific and technical stewardship for decadal-survey recommended missions:

- 3 of the 6 highly-ranked medium and large-scale space-based priorities in NWNH fall within the PCOS science program:
 - LISA (Gravitational Waves)
 - IXO (X-ray)
 - Inflation Probe (medium-scale)
- NOTE: Although dark energy SCIENCE is within PCOS program, WFIRST is located within the Exoplanet Program



2016 update includes:

- Response to Midterm Assessment
- Planning for 2020 Decadal Survey