



Astrophysics



**Astrophysics Probes
Mission Concept Studies
for PCOS Science Themes**

August 22, 2017

www.nasa.gov

Rita Sambruna
*PCOS Program Scientist
Astrophysics Probe Studies
Program Officer
NASA Headquarters*

Astrophysics Probes Studies



- One of the tasks of the Decadal will be to recommend a portfolio of astrophysics missions. The Decadal may choose to recommend a portfolio of missions containing a mix of prioritized large- and medium-size mission concepts, or even a program of competed medium-size missions.
- To help the community, NASA has started 10 Studies(selected competitively) for Astrophysics Probe-size Mission Concepts that address the science goal of NASA's Astrophysics Division
- Definition of Probe: *"Astrophysics Probes are envisioned to have a total lifecycle (NASA Phases A through E) cost between that of a MIDEX mission (~\$400M) and ~\$1B."*
- Each selected Study Team received up to \$150K for conducting an 18-months study of the science goals and technical feasibility. NASA also supported feasibility runs at JPL and Goddard Space Flight Centers, and will fund an Independent Cost Assessment at SOMA, Langley, at the end of the 18-month study
- The written reports will be delivered to NASA by early 2019. NASA will then deliver them to the 2020 Decadal Survey Committee

PCOS-related Selected Probes Studies



PI	Affiliation	Short Title/Mission Name
J. Camp	NASA's GSFC	Transient Astrophysics Probe (TAP)
S. Hanany	Univ. of Minnesota	Inflation Probe (IP)
R. Mushotzky	Univ. of Maryland	High Spatial Resolution X-ray Probe (AXIS)
A. Olinto	Univ. of Chicago	Multi-messenger Astrophysics (POEMMA)
P. Ray	Naval Research Lab	X-ray Timing and Spectroscopy (STROBE-X)

See other sessions and posters for related presentations by the Teams

Transient Astrophysics Probe (TAP)

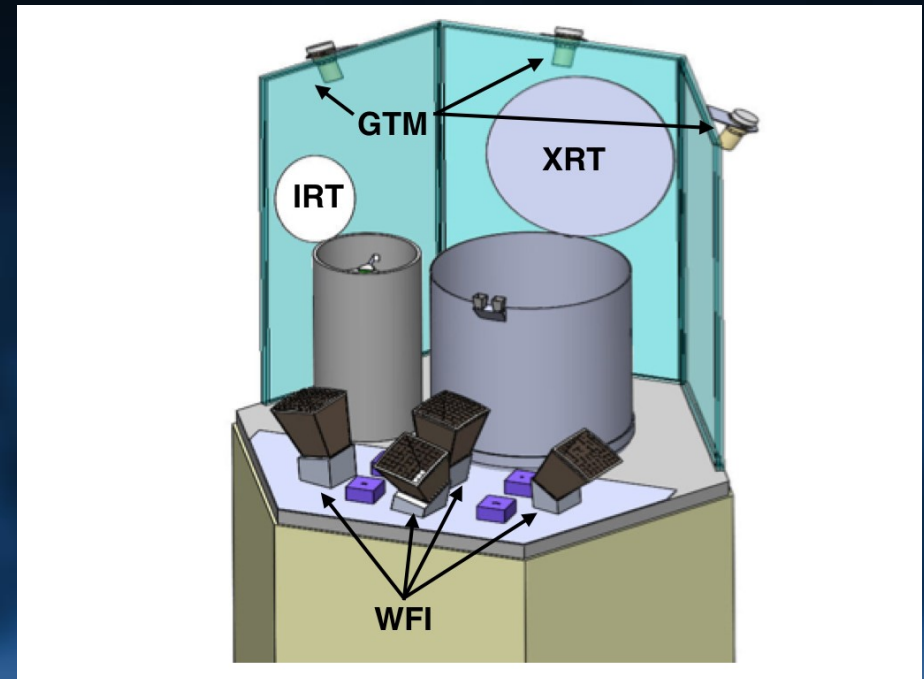
J. Camp, NASA's GSFC

Science Goals:

- Electromagnetic Counterparts of Gravitational Waves (LIGO network)
- Time Domain Astrophysics: Supernovae, Tidal Disruption Events, High Redshift GRBs
- 10% ToO, 90% all-sky survey mode

Mission Description:

- TAP is designed to respond to targets of opportunity with SWIFT-like speeds
- The TAP mission concept instrument suite is made up by the Wide-field sensitive soft X-ray telescope, the Wide-field sensitive IR telescope, four all-sky Lobster soft X-ray modules, and four Gamma-ray burst monitors
- TAP uses low-latency links and a fast



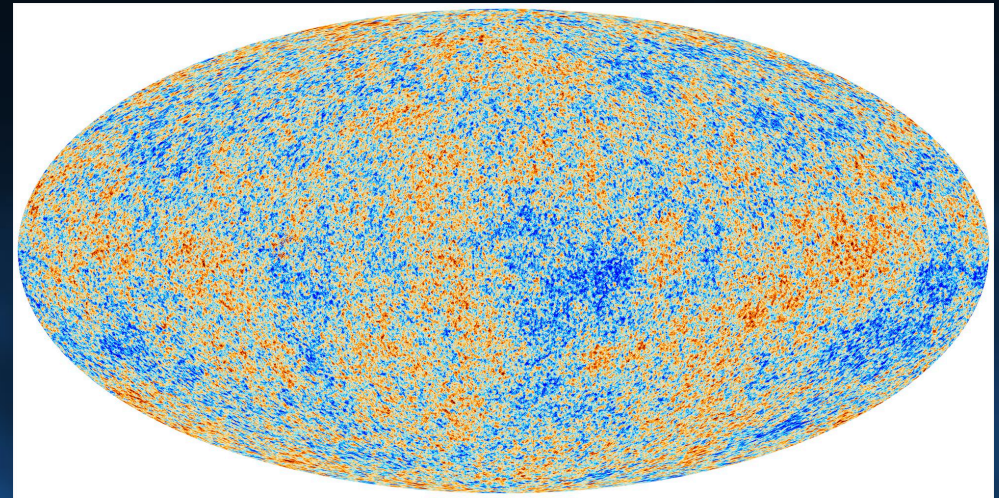
- slewing spacecraft similar to SWIFT.
- TAP may be stationed at L2 for a large Field of Regard and more stable communication environment
- 5 year mission life

Science Goals:

- Probe the physics of the big bang and of quantum gravity by searching for the energy scale at which Inflation occurred
- Test the Standard Model of particle physics by measuring the number of light particles in the Universe and the mass of the neutrino
- Elucidate the nature of dark matter and search for new forms of matter in the early universe
- Measure the reionization and star formation history over cosmic time
- Determine the mechanisms of structure formation, from galaxy cluster to stellar scales

Mission Description:

- Cosmic microwave background polarization imager and spectrometer
- All sky survey
- Exquisite measurement of foregrounds with 20 frequency bands between 20 – 800 GHz



Mission Description (cont.):

- High resolution imager: bolometric camera with transition edge sensors cooled to 0.1 K
- Low resolution Fourier transform spectrometer
- 4 year mission at L2

Science Goals:

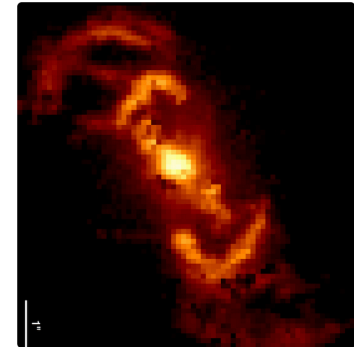
- Galaxies over Cosmic Time
- Merging Black Holes
- Feedback in Galaxies
- Black Hole Strong Gravity

Mission Description:

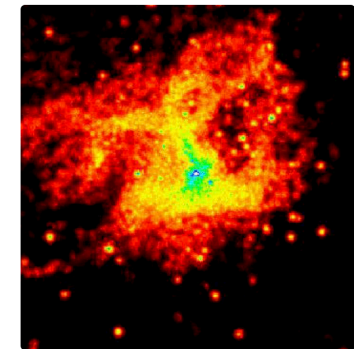
- New lightweight single-crystal silicon optics with high angular resolution and collecting area and a modern CCD with higher sensitivity and spectral resolution than Chandra
- LEO orbit will minimize background, allow rapid slewing for TOOs and extend lifetime (>5 yrs, no consumables)

Angular Resolution	~0.3 arc sec
Bandpass	~0.1-12 keV
Effective Area	4000 cm ² @1 keV; 1000 cm ² @ 6Kev
Energy Resolution	150 eV @ 6 keV (CCD resolution)
Total count rate /source	10x Chandra's at launch
Detector Background	5x lower than Chandra

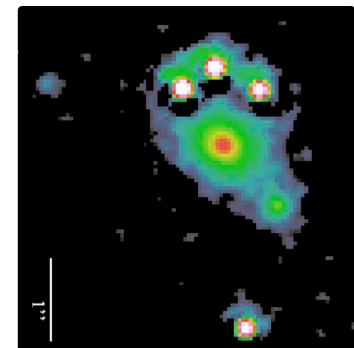
Galaxies Over Cosmic Time



Feedback in Galaxies



Black Hole Strong Gravity



Science Goals:

- Identify the sources of the most extreme particles ever observed: ultra-high energy cosmic rays (UHECRs)
- Observe neutrinos above 0.1 EeV
- Understand how the sources of UHECRs work
- Determine the composition, spectrum and sky distributions at energies above 10 EeV
- Study interactions of particles at energies much beyond artificial accelerators.

Mission Description:

- POEMMA is a constellation of two identical spacecraft flying a few hundred km apart in a circular 525 km 28 deg orbit, executing coordinated stereo observations of particle showers on the night side of Earth's atmosphere



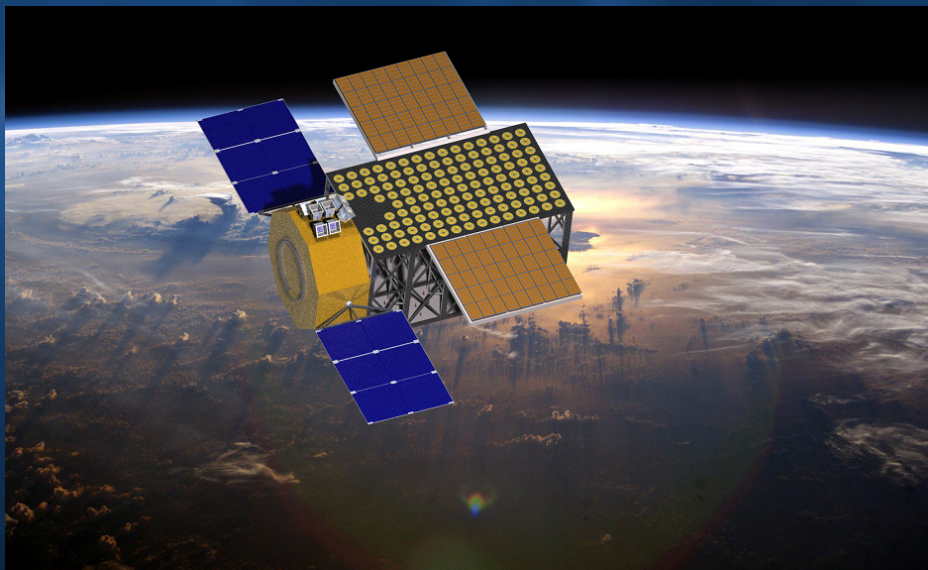
- Payload on each satellite: 6.5 meter f/0.77 Schmidt telescope, MAPMT and SiPM focal surface
- 3 year mission life
- Single dual manifest launch in an Atlas V LV

STROBE-X

P. Ray, NRL

Science Goals:

- Strong-field gravity near black holes
- Black hole accretion flows across all mass scales: reverberation mapping of stellar-mass BHs, IMBHs, and AGN
- Neutron star astrophysics
- Cosmic chemical evolution: bulk metallicity survey of high-redshift galaxy clusters (pathfinder project)
- Continuous survey of dynamic X-ray sky with high duty cycle and sensitivity



Mission Description:

- Three instruments provide broadband X-ray coverage, good spectral resolution, and sub-millisecond timing
 - **X-ray Concentrator Array (XRCA):** 0.2–12 keV with 18x area of NICER; CCD resolution; low background enables extragalactic targets (NICER heritage)
 - **Large Area Detector (LAD):** 2–30 keV with >10x area of RXTE PCA (based on LOFT)
 - **Wide Field Monitor (WFM):** 2–50 keV
- Flexible 3-axis pointing over a large fraction of the sky
- Falcon 9 launch into a LEO orbit, as low inclination as possible

Decadal Splinter Sessions at Winter AAS



- NASA is sponsoring two splinter sessions at the Winter 2018 AAS meeting on **Tuesday, January 9:**
 - Large Scale Studies 10:00-11:30am
 - Probes Studies 2:00-3:30pm
- An adjacent poster session for the Probe Studies is also planned

Special Thanks to the Probe Studies POCs:

Gabe Karpati, PCOS/COR, GSFC

Keith Warfield, ExeP, JPL

Backup





Selected Probe Mission Concept Studies

PI	Affiliation	Short title	Design Lab/Prog Office
Camp, J.	NASA's GSFC	Transient Astrophysics Probe	IDC/PCOS-COR
Cooray, A.	Univ. California, Irvine	Cosmic Dawn Intensity Mapper	TeamX/ExEP
Danchi, W.	GSFC	Cosmic Evolution through UV spectroscopy	IDC/PCOS-COR
Glenn, J.	Univ. of Colorado	Galaxy Evolution Probe	TeamX/ExEP
Hanany, S.	Univ. of Minnesota	Inflation Probe Mission Concept Study	TeamX/ExEP
Mushotzky, R.	Univ. of Maryland	High Spatial Resolution X-ray Probe	IDC/PCOS-COR
Olinto, A.	Univ. of Chicago	Multi-Messenger Astrophysics	IDC/PCOS-COR
Plavchan, P.	Missouri State Univ.	Precise Radial Velocity Observatory	No design lab funded/HQ grant
Ray, P.	Naval Research Lab	X-ray Timing and Spectroscopy	IDC/PCOS-COR
Seager, S.	MIT	Starshade Rendezvous	TeamX/ExEP