X-ray Science Interest Group Meeting

April 5, 2016 HEAD Meeting, Naples FL

Agenda

Welcome

Mark Bautz, MIT; Ralph Kraft, SAO

Optics Workshop Report

Mark Schattenburg, MIT

Athena Update

Randall Smith, SAO

X-ray Surveyor Mission Study Q & A

Jessica Gaskin, MSFC; Alexey Vikhlinin, SAO

Probe missions: NASA preparations for the 2020 Decadal

Mark Bautz, MIT

Discussion

Origin of the Probes Charge: You asked for it

- In 2015 NASA Astrophysics Director Paul Hertz charged all 3 Program Analysis Groups (PAGS: Physics of the Cosmos, Cosmic Origins, and Exo-planets) to recommend large missions that should be studied in preparation for the 2020 Decadal Survey.

- In October 2015, the PAGS unanimously recommended four large missions for study; each now has a Science and Technology Definition Team.

- In response to community input, the PAGS also recommended that NASA study somewhat smaller missions ("Probe"-class, costing ~$1) in preparation for the Decadal Survey.
  - **The 2015 HEAD meeting in Chicago was a key part of this process!**

Summary of the Probes Charge

On 14 January 2016 the PAGs were charged to evaluate two options for developing probe-class missions for the Decadal survey:

1. Issue a solicitation through ROSES for Astrophysics Probe mission concept study proposals. The proposals will be evaluated via a peer-review process and APD will select a few (~10) for one-year studies. A modest (~$100K) amount of funding would be allocated for each study; cost assessment mechanisms would need to be discussed. The results of the studies would be presented to the Decadal Survey Committee. The Decadal Survey Committee would have the option of asking NASA to conduct further one-year studies at a higher level of detail (and at a higher cost for each study) for a small number (~3) of medium mission concepts.
2. Do nothing and let the community self-organize. Most likely this will result in submission of many white papers to the 2020 Decadal Survey from interested individuals and groups, as during the 2010 Decadal Survey.

Gathering Community Input and PAG Coordination

Date	Location	Meeting
1 July 2015	Chicago, IL	X-ray and Gamma-ray SIG meet at AAS High Energy Astrophysics Division
		High-energy astrophysics probe concepts developed
3 Jan 2016	Kissimmee, FL	Joint PAG open session on probes at **AAS**
3 January	Kissimmee, FL	PhysPAG EC meeting & probes discussion
		Presentation on CATE process from Aerospace
27 January	Email	PhysPAG issues call for 2-page probe white papers
8 February	Telecon	Joint PAG discussion about joint response
1 March	Email	14 probe white papers received from PCOS community

Joint PAG Statement on Probes

The COPAG, ExoPAG, and PhysPAG all agree that NASA should support the development of a probe class of competed missions for the Decadal survey. All three PAGs strongly support the first option proposed by Paul Hertz in his formal charge to the PAGs of January 14, 2016. Based on the input the three communities have received, there exists a wide range of community science goals that are both consistent with current National Academy priorities and that can be enabled with medium-class missions. The three PAGs also note that the work of preparing high quality white paper proposals to the 2020 Decadal Survey, for missions of this class, cannot be performed absent funding. In particular, all three PAGs agree that competed NASA HQ funds should allow at least 10 concepts for probe-class missions to be studied in some depth. However, the main concern associated with this first option is that limiting the funds available for each concept study to ~$100K will likely severely limit the veracity of the CATE analyses at this early phase, even though funds would be provided for more detailed CATE analyses when requested at a later phase by the Decadal Survey committee. We recommend that APD consider apportioning sufficient funds to carry out multiple CATE analyses that would apply to the general category of probe missions in advance of the Decadal Survey.

Summary of PhysPAG Probe Findings (#1)

We find broad and enthusiastic support in the PCOS community for furthering the development of probe-class missions, conceived as a new large mission class of the PI-led competed missions in the Explorer program.

- As an example of this enthusiasm, we have received 14 white paper concepts from the community spanning PCOS science themes.
- We believe a scientific niche has been missing in the APD portfolio for competed, cost-capped missions in this price range. The success of the ESA M-class mission category testifies to the scientific effectiveness of such a program. We also note several NASA missions close to this cost point that have been successful in carrying out astronomical science (e.g. Fermi, Kepler, Spitzer).
- In the PCOS community, there is widespread support for the Explorer program in carrying out cost-effective science.

Summary of PCOS Probe White Papers (1/2)

Name	First/Lead Author	Type	Spectral Range	Science	Cost	Launch & ops?
High-Energy X-Ray Probe (HEX-P)	F. Harrison	X-Ray	2-200 keV	Resolve X-Ray background, evolution of black hole spin, faint X-ray populations in nearby galaxies	$500M	Included
A Wide-Field X-Ray Probe	A. Ptak	X-Ray	~1-10 keV	Measure mass and spatial distribution of clusters and AGN, define LF of AGN	$540M / $740M	Not included
An X-Ray Grating Spectroscopy Probe	R. McEntaffer	X-Ray	5-50 Angstrom	Role of SMBH feedback in galaxy formation, distribution of hot baryons, characteristics of Galaxy's hot halo, GW counterparts	$784M	Included
AMEGO: A Medium-Energy Gamma-Ray Surveyor	J. McEnery	Gamma-Ray	0.2 MeV - 10 GeV	Time-domain GW counterparts, improved MeV surveying, nuclear line emission	$600-$800M	Included
Advanced Particle-Astrophysics Telescope (APT)	J. Buckley	Gamma-Ray	100 MeV - 50 GeV	Definitive dark matter search, all-sky transient survey, GW counterparts	Probe-class	Not stated
A Large Observatory for X-Ray Timing Probe (LOFT-P)	C. Wilson-Hodge	X-Ray timing	2 - 30 keV	Strong gravity and BH spins, matter in neutron stars, surveying the dynamic X-Ray sky, multi-messenger studies	$770M	Included
Death of Massive Stars (DoMaS)	P. Roming	Transients	X-ray/UV/IR	Study massive stars at reionization via GRBs and SNs.	$760M	Not stated

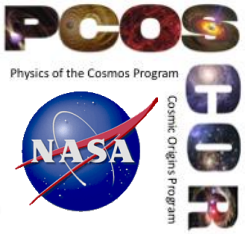
Summary of PCOS Probe White Papers (2/2)

Name	First Author	Type	Spectral Range	Science	Cost	Launch & ops?
Transient Astrophysics Probe (TAP)	J. Camp	Transients	X-ray/IR	Epoch of reionization from high-z GRBs and SNs, survey of the X-Ray sky, GW counterparts	$750M	Included
The Time-Domain Spectroscopic Observatory (TSO)	J. Grindlay	Transients	0.4 - 5 um	Epoch of reionization from high-z GRBs studies, growth of SMBHs over cosmic time, GW counterparts, transient discoveries	$650M	Included
GreatOWL: A Space-Based Mission for Charged-Particle and Neutrino Astronomy	J. Mitchell	Cosmic Ray	-	Nature of ultra-high energy cosmic rays, GZK-induced neutrinos	$540M	Not included
The Inflation Probe	NASA IPSIG	CMB	30 - 300 GHz	Inflationary gravitational wave background, reionization, large-scale structure, neutrinos	Probe-class	Not stated
Probe-Class Mission Concepts for Studying mHz Gravitational Waves	M. Tinto	Gravitational-wave	1 mHz – 10 Hz	Spiraling massive and super-massive black holes, BH formation, tests of strong gravity,distribution of white dwarf binaries	$560M / $900M	Not stated
A Probe-Class Gravitational-Wave Observatory	S. McWilliams	Gravitational-wave	1 mHz – 10 Hz	Massive BH binary mergers, stellar-mass BH and NS mergers, probe dark energy via z-L measurements	$830M - $1.2M	Included
99 Luftballons	T. Eifler	UV/Optical	270 - 1000 nm	Nature of dark energy, neutrino masses, tests of gravity	Not stated	ULDB

Summary of PhysPAG Probe Findings (#2)

The PhysPAG endorses option 1 given in the charge, undertaking an initial study of ~10 1-year concept studies at ~$100k each, as an initial step.

Summary of PhysPAG Probe Findings (#3)



However we are concerned that the cost information presented to the Decadal review will be insufficient.

- The initial $100k studies will not have the financial resources and schedule required to achieve the level of cost fidelity required by the Decadal.
- We feel the second step in option 1 “conducting further one-year studies at a higher level of detail (and at a higher cost for each study) for a small number (~3) of medium mission concepts” needs to take place well before the Decadal survey. Costing these mission concepts during the Decadal study may not be successful given the inevitable time pressure of a Decadal review. We note the past practice of the Decadal cost and technical evaluation (CATE) process, in evaluating the fidelity of well-defined costed missions, may be problematic for probe mission concepts developed from these preliminary studies.
- Our interactions with commercial cost modelers indicate that cost studies should incorporate input from non-NASA modelers early on, to assure better agreement with the Decadal CATE process, which further extends the duration and complexity of the studies.

Summary of PhysPAG Probe Findings (#4)

We suggest that APD develop a second phase of studies to define costs for general probe missions, and to better determine the optimal cost point.

- Given the input we received on white papers, with many concepts in the lower end of the price range, it appears that certain concepts could fit well below the $1B total. If so, this would be an important finding for Decadal survey planning as it bears on the frequency of mission opportunities.
- While the cost studies may be best developed on specific scientific concepts, the findings must apply generally to the probe mission class.

Summary of PhysPAG Probe Findings (#5)

We note that the Inflation Probe is unique in that it was recommended by the 2010 Decadal Survey. Studies for its development would directly apply to developing the probe mission category for the 2020 Decadal Survey.

Path Forward on Cost Analysis

There are several (possibly overlapping) options available to develop a reliable cost model. We do not have a finding for a preferred option.

1) Provide sufficient support for the 10 studies to produce costs
2) Select a reduced number for a second-phase cost analysis
3) Cost “exemplar” concepts that are scientifically defined but apply to general types of likely probe missions
4) Use the inflation probe as one “exemplar” concept