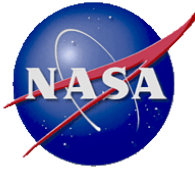




The U.S. Situation

Robin Stebbins
eLISA Consortium Meeting
APC, Paris, 22 October 2012



Outline

Focus: Re-establishing an ESA-NASA partnership.

- Results of the Gravitational-Wave mission concept study
- The Astrophysics Division at NASA Headquarters
 - Changes in the Division
 - The budget reality
 - The budget strategy
- A scenario leading to an ESA-NASA partnership
- Technology development plan
- Near-Term Actions

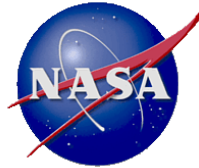


RESULTS OF THE GRAVITATIONAL WAVE MISSION CONCEPT STUDY



Goals, Elements and Activities

- Goals
 - Develop mission concepts that will accomplish some or all of the LISA science objectives at lower cost points
 - Explore how architectural choices affect science, risk and cost
 - Identify key enabling technologies
- Elements: the research community, Core Team, Community Science Team, Science Task Force, Team X
- Activities
 - RFI, public workshop, open house, ‘in-breeding’
 - Core Team analyses, CST analyses, science analyses, Team X studies (4), Study team deliberations, “Abstracting” for the Final Report



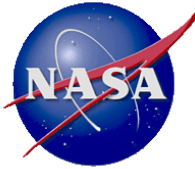
Science, Risk and Cost

Science Performance	SGO High	SGO Mid	LAGRANGE/ McKenzie	OMEGA Option 1	OMEGA Option 2
Massive Black Hole Binaries					
Total detected	108–220	41–52	37–45	21–32	21–32
Detected at $z \geq 10$	3–57	1–4	1–5	1–6	1–6
Both mass errors $\leq 1\%$	67–171	18–42	8–25	11–26	11–26
One spin error $\leq 1\%$	49–130	11–27	3–11	7–18	7–18
Both spin errors $\leq 1\%$	1–17	<1	0	<1	<1
Distance error $\leq 3\%$	81–108	12–22	2–6	10–17	10–17
Sky location $\leq 1 \text{ deg}^2$	71–112	14–21	2–4	15–18	15–18
Sky location $\leq 0.1 \text{ deg}^2$	22–51	4–8	≤ 1	5–8	5–8
Total EMRIs detected [†]	800	~35	~20	~15	~15
WD binaries detected (resolved)	4×10^4	7×10^3	5×10^3	5×10^3	5×10^3
WD binaries with 3D location	8×10^3	8×10^2	3×10^2	1.5×10^2	1.5×10^2
Stochastic Background Sensitivity (rel. to LISA)	1.0	0.2	0.15*	0.25	0.25
Top Team X Risk	Moderate [‡]	Low	Moderate	Moderate	High
Top Team X + Core Team Risk	Moderate [‡]	Low	High	High	High
Team X Cost Estimate (FY 12\$)	2.1B	1.9B	1.6B	1.4B	1.2B

[†] Based on median rate; estimates for EMRI rates vary by as much as an order of magnitude in each direction.

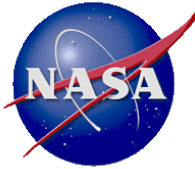
* Two-arm instruments such as LAGRANGE/McKenzie lack the "GW null" channel that can be used to distinguish between stochastic backgrounds & instrumental noise, making such measurements more challenging.

[‡] The moderate risk for SGO High comes about from the thruster development necessary to demonstrate the required lifetime for 5 years of science operations.



General Findings

- Scientifically compelling mission concepts can be carried out for less than the full LISA cost. No concepts were found near or below \$1B.
- Scaling the LISA architecture with 3 arms down to the SGO Mid concept preserves compelling science, reduces cost and maintains low risk.
- Eliminating a measurement arm reduces costs modestly, reduces science and increases mission risk.
- More drastic changes, such as eliminating drag-free operation or adopting a geocentric orbit, significantly increase risk, and the associated cost savings are uncertain.
- Scientific performance decreases far more rapidly than cost.
- We have found no technology that can make a dramatic reduction in cost.
- There is an urgent need for NASA to prepare for the imminent exploration of the Universe with gravitational waves, leading to revolutionary science. The U.S. needs a sustained and significant program supporting technology development and science studies to participate in the first space-based gravitational-wave mission.

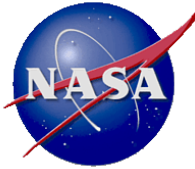


Mission Concept Study Report

- The final study report can be downloaded from:
<http://pcos.gsfc.nasa.gov/studies/gravitational-wave-mission.php>
- Additional information at the same location:
 - Request for Information (RFI)
 - Team-X Study Summaries
 - Team X Final Study Reports
 - Links to presentations and other study documents



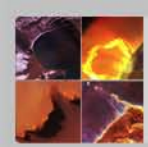
THE ASTROPHYSICS DIVISION AT NASA HEADQUARTERS



Changes at Astrophysics Division, NASA HQ

- Paul Hertz has been the Division Director for about a year
 - X-ray astronomer, long ago
 - Been associated with Astrophysics or the Science Mission Directorate for >15 years
 - Some history with LISA, notably the 2003 TRIP review
- Staff turnover in August and September
 - Many Program Executives and Program Scientists associated with the Physics of the Cosmos program have left.
 - Replacements are in place. Brain-washing ongoing.
 - Joan Centrella has taken a 1 year detail to be Paul's deputy for strategic planning
 - The NRO telescopes

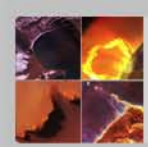
The next 5 slides are taken from Paul Hertz's presentation to the Fourth PhysPAG Meeting, Washington, DC, 14-16 Aug. 2012



Astrophysics Budget Reality

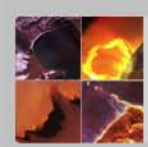
- There is inadequate available budget to implement the Astro2010 Decadal Survey recommendations as written; there is also changed external context.
 - Due to budget constraints, no new missions other than Explorers can enter formulation before FY17 (when JWST approaches launch).
 - ESA has ended the joint LISA and IXO studies.
- Currently there are no new starts for large missions.
 - NASA must earn back the privilege of starting large missions.
- Large strategic missions in the future are possible only if the Astrophysics budget recovers a large portion of the funds freed up as the JWST budget begins to decrease in FY18 and out.

The goal is to start a new strategic astrophysics mission as soon as funding becomes available while continuing to advance the science during the interim.



Astrophysics Budget Strategy

- Use the scientific priorities of the Astro2010 Decadal Survey to guide strategy and inform choices.
- In the absence of new missions, progress against decadal priorities is maintained through the core research program, through continued operation of existing missions and their GO programs, through the suborbital programs, and through frequent Explorer opportunities.
 - Support for all of these is maintained in the President's FY13 budget request.
- In order to prepare for a new mission starting in FY17, a near term program of mission concept studies and technology development will be undertaken, with the goal of informing a mid-decade decision on which mission(s) will begin formulation starting in FY17
 - Currently there are no new starts for large missions. Moderate missions ("probes") must be considered for start in FY17, in addition to a large mission (e.g., WFIRST), to be prepared for a mid-decade decision.
 - Mission concepts studied must derive from the science of the missions and recommendations prioritized in the Decadal Survey.



Astrophysics Budget Strategy

2012

- Study WFIRST options.
- Solicit ideas from the community for studies of moderate missions that address DS priorities.
- Establish community study teams for mission concepts.
- Initiate mission concept studies within the programs.
- Use community analysis groups to inform process.

2013

- Use competed and directed technology programs to develop enabling technology and mission concepts.

2014

- Continue from 2013.

2015

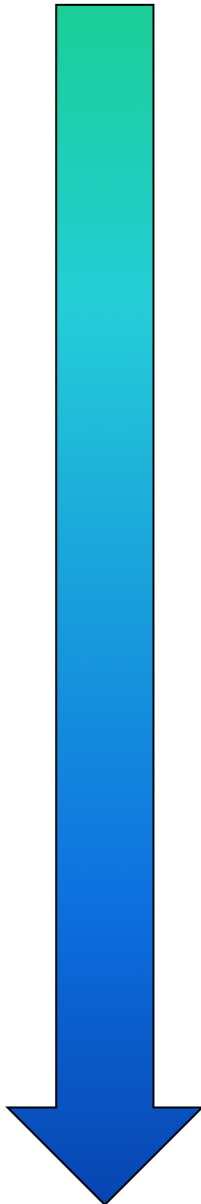
- Using community input, conduct prioritization and decision process for identifying FY17 new start.
- Start pre-formulation for new FY17 strategic mission.
- Start NRC mid-decade review.

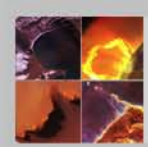
2016

- Complete mid-decade review. Revise plans as necessary in response to report.

2017

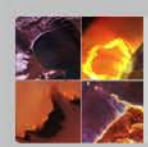
- New start for strategic mission.





Astrophysics Budget Strategy

- Mission concept studies generate candidates for future strategic missions
 - An FY17 new start and an efficient development requires mature technology
 - Mission concept studies identify technology requirements, and this guides technology investment
- Mission concepts studied must derive from the science of the missions and recommendations prioritized in the Decadal Survey.
 - WFIRST DRM1 and DRM2 (done)
 - Gravity wave concepts to advance the LISA science (done)
 - X-ray concept studies to advance the IXO science (done)
 - UV/Vis science objectives to drive concept studies (probes?) and technology that advances the science of a future UV telescope (underway)
 - Use of NRO telescopes to advance WFIRST science (planned)
 - Exoplanet probe concept studies to advance science of a planet imaging mission (planned)
 - Additional concept studies will be undertaken

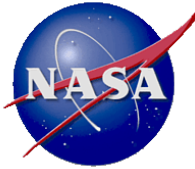


Astrophysics Budget Strategy

- A white paper describing the response to the Decadal Survey recommendations, consistent with current budget guidance, is under development.
 - Will review with Committee on Astronomy and Astrophysics and Astrophysics Subcommittee in the Fall.
 - Will release to the community before Long Beach AAS meeting.
- Will outline calls and studies planned to prepare for:
 - Mid-decade decision to start a new strategic mission after JWST (and possibly a second mission, depending on out-year budget guidance).
 - Mid-decade review.
 - Next decadal survey.
- Basic content is already known.
 - Competed and directed technology development in response to technology prioritizations.
 - RFIs and study teams for missions and probes (e.g., X-ray, Gravitational wave, UV/Visible,)
 - Studies of potential missions leading to concept studies, e.g., WFIRST (DRM1), WFIRST probe (DRM2), Use of NRO telescopes, Exoplanet probes, X-ray mission concepts, GW mission concepts, other probes, etc.

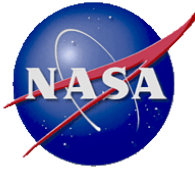


A SCENARIO LEADING TO AN ESA-NASA PARTNERSHIP



ESA-led Mission (1/3)

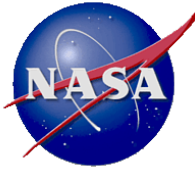
- ESA is expected to initiate a call for the L2 and L3 (Large/ Cornerstone) mission opportunities in the near future.
- If invited, NASA could participate as a minority partner in an ESA-led mission, with a “probe-class” investment (~\$100-600 M).
- ESA cost cap ~850 M€, member state contributions ~200 M€
- The eLISA Consortium has been formed and will likely propose the New Gravitational-Wave Observatory (NGO) concept as a ‘notional’ mission for the Cornerstone proposal.
- NGO, a two-arm scaled-down version of LISA, was costed at 1,060 M€ for ESA’s portion of L1.
- NASA could enable the addition of a third arm adding science benefit with little, if any, additional cost. This mission concept is essentially equivalent to SGO-Mid.



ESA-led Mission (2/3)

A possible timeline

- Call for science theme (cornerstone) proposals in 2013. Selection in late 2013.
- Brief study of concepts
- Call for mission concepts in late 2014, selection in late 2015.
- LISA Pathfinder in 2015/2016 (NWNH tripwire)
- Concept studies (Phase A)
- Sequence L2/L3 in late 2016 or early 2017.



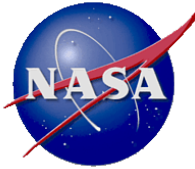
ESA-led Mission (3/3)

What does NASA have to do to participate?

- Track the evolution of the ESA L2/L3 process over the next year
- Ascertain the conditions for a partnership
 - Participation in concept definition
 - Technology development for potential hardware contributions
 - Milestones for technology and commitment
- Sustain the research community to work on science case
- Synchronize technology and conceptual activities with ESA time line.
- Demonstrate convincing level of commitment to ESA
- Focus on value-added concept definition work

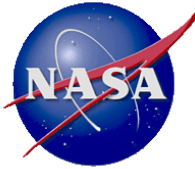


NRC COMMITTEE ON ASTRONOMY AND ASTROPHYSICS (CAA)



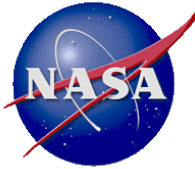
CAA Meeting

- The Committee on Astronomy and Astrophysics
 - A standing committee of the National Research Council, lasts until the next decadal begins
 - The interpreters of, and advisors on, the 2010 decadal recommendations (NWNH)
- Last Tuesday, the CAA asked “... to hear [my] views on what NASA should be doing to enable future missions given that IXO and LISA are not likely to happen in this decade.”
- My answer was based on two scenarios
 - A near-term partnership led by ESA (see earlier charts)
 - A post-2020 partnership led by NASA

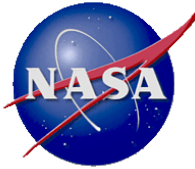


CAA Response

- They recognized
 - The opportunity for a facility-class mission that did NWNH science at probe-class prices
 - Any recommendations that they might have, now or in 2015, would have to take Europe into account.
- They see a similar dynamic in Euclid/WFIRST, Athena/AXSIO and possibly exoplanets.
- A co-chair suggested that they have an entire session on working with international partners.
 - Hertz suggested that an ESA process would be known about the end of the year.

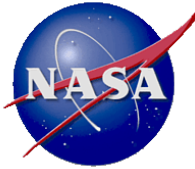


TECHNOLOGY DEVELOPMENT



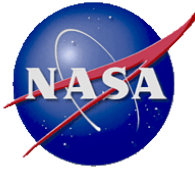
Technology Development Plan (1/3)

- The GW Study Team is working on a new Technology Development Plan, scheduled for completion in March 2013.
- It will be adaptable to both the ESA-led near-term scenario and the NASA-led long-term scenario.
- ESA-led mission: TRL 5 at the subsystem level by mid-CY16



Technology Development Plan (2/3)

- Critical technology areas (appropriate to near-term ESA opportunity)
 - Telescope subsystem: pathlength stability, scattered light
 - Laser subsystem: subsystem integration, lifetime, reliability
 - Micronewton thrusters: lifetime, maximum thrust, larger propellant capacity
 - Phase measurement subsystem: subsystem integration for higher TRL tests
- The plan subject to review in 2015/2016, when the strategic path forward is known.

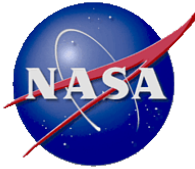


Technology Development Plan (3/3)

- Participation in ST7 is an extraordinary opportunity to leverage past investment, to engage community and gain insight into core technologies.

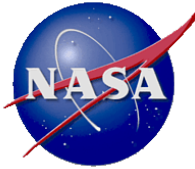


NEAR-TERM ACTIONS



Re-Establishing a Partnership

- Synchronizing the Agencies
 - Coordinate decision processes
 - Establishing either a joint science team, or a single agency science team with observers
 - Coordinating concepts, and concept definition
 - Coordinating technology developments
- Defining the process at each Agency
 - NASA promises a whitepaper before early January
 - ESA? 1-2 months after Ministerial, say January?
- Milestones to look for
 - When is the concept frozen? How frozen?
 - This drives technology development at higher TRLs



Re-Establishing a Partnership

- More milestones to look for
 - When are the partnerships frozen? How frozen?
 - How well defined do the contributions have to be?
 - When does the partner's technology have to be ready?
 - When the L2/L3 ordering happens, does the partner have to have mature (TRL 5 or 6) technology or a plan to mature the technology (TRL5 by Phase A start, TRL 6 by PDR)
- Support ST7 and LPF
 - Increased participation by the community
 - Proposal for joint operations