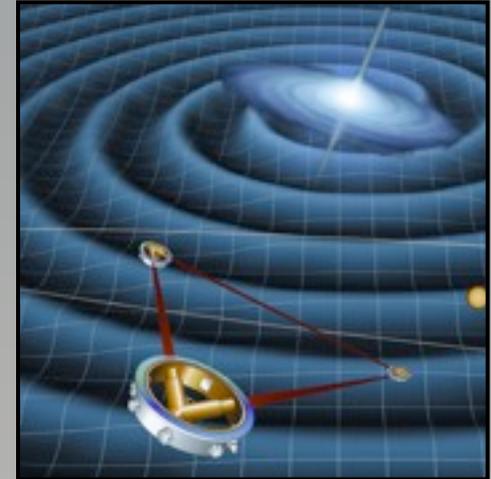
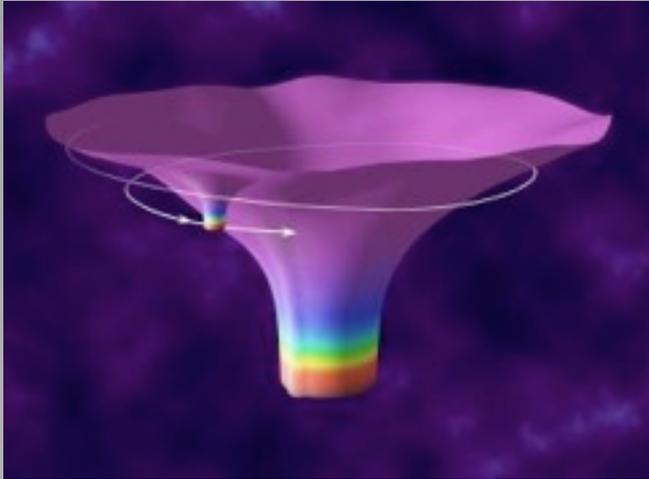


# Gravitational Wave Science Analysis Group GW-SAG



**Inaugural meeting  
Washington, DC  
August 14-15, 2012**

# PhysPAG within PCOS

## PCOS Program Analysis Group (PhysPAG)

- **Forum for** soliciting and coordinating **input and analysis** from the scientific community
  - enables direct and regular communication through public meetings
- **Open:** All interested scientists can contribute to the PhysPAG by participating in the PhysPAG meetings and by providing their input.
  - The **Executive Committee (EC)** is appointed by NASA with the concurrence of the [Astrophysics Subcommittee](#) (APS)
  - Collect and summarize community input with subsequent reporting to NASA SMD via the [NAC](#) (NASA Advisory Council).

# PhysPAG within PCOS

## PhysPAG: Executive Committee (EC)

Steve Ritz (Chair) - University of California, Santa Cruz

Jason Rhodes - Jet Propulsion Laboratory - WFIRST

Shaul Hanany - University of Minnesota - Inflation Probe

Jay Bookbinder - Harvard-Smithsonian Center for Astrophysics - X-ray

Liz Hays - NASA Goddard Space Flight Center - Gamma Ray

Guido Mueller - University of Florida - GW

Rita Sambruna (Executive Secretary, Ex-Officio) - NASA HQ

Ann Hornschemeier (PCOS Program Office, Ex-Officio) - NASA GSFC

- Many disciplines are represented in the EC
  - Most disciplines have a study (or science) analysis group
- The PhysPAG is **NOT** a group that will advocate for a specific GW-mission or any other specific mission

# GW-SAG within PhysPAG/PCOS/NASA

The goal of the Gravitational Wave Science Analysis Group (GWSAG) is to provide quantitative metrics and assessments to NASA in regard to a future Gravitational Wave mission. Specifically, the GWSAG will

- **Track and analyze evolving science goals and requirements**, especially as our understanding of three standard sources of gravitational waves (SMBH, EMRI, GB) continues to improve.
- **Support mission studies and concept development** for future space-based gravitational wave observatories, including where cost savings are sought and/or new classes of sources are to be considered (e.g., stochastic GW background from the Big Bang).
- **Analyze technology development and prioritization plans** with respect to redefined science goals and the evolution of mission concepts (i.e., the GWSAG will aid the PhysPAG in analyzing technology needs).
- **Advocate for gravitational wave astrophysics and astronomy** and explain the importance of this new field to the wider scientific community and also to the public.

The GWSAG is open to all members of the community ... and has a mailing list

Subscribe at: [GWSAG-subscribe@lists.nasa.gov](mailto:GWSAG-subscribe@lists.nasa.gov) 

# GW SAG

- GW-SAG
  1. US Counterpart of the scientific part of the European Consortium
  2. Replaces to some degree US part of LIST
  3. Provides community input and outside expertise for Technology development plans
  4. Advocacy
- Open group with no funding ...
  - Have to depend on telecons, wikis, and occasional meetings at larger conferences
  - Form is probably only sustainable if at least key members receive funding for related research activities
  - But we have to get started ...

# How do we organize the GW-SAG?

Currently have two weekly telecons in US:

1. Former project telecon incl. our former European partners
2. US Core Team to discuss technology (US only)

My suggestion:

- GW SAG members can join them
  - to stay up to date on current developments and future events
- Organize additional telecons/web meetings as needed

PCOS office organized mailing list and offered to support a wiki page.

# How do we organize GW-SAG?

We probably need three subgroups

- Science (Lead: Neil Cornish)
- Technology (Lead: GM)
- Advocacy (Lead: ??)

Leads will activate/organize subgroup for specific tasks/events

Examples:

- Calculate detection rates and parameter for new mission design  
(Science group)
- Develop technology plan, prioritize technologies, evaluate new ideas  
(Technology supports Core Team)
- Organize/Coordinate activities at meetings (Advocacy)

# How do we organize GW-SAG?

Some other activities:

- Push for invited talks and dedicated sessions at APS, AAS, HEAD, COSPAR, MG and other meetings and conferences
- Replace the LIST in the organization of the LISA Symposium
  - next June/July @ UF
  - Program or Scientific Advisory Boards
    - LIST: WG chairs did organize parallel sessions
  - Selecting next hosts (that could be done by GWIC)

# How do we organize GW-SAG?

Some other activities:

- Push for invited talks and dedicated sessions at APS, AAS, HEAD, COSPAR, MG and other meetings and conferences

- Replace the **Any Comments/Questions/Suggestions?** ium
  - next June/July @ CI
  - Program or Scientific Advisory Boards
    - LIST: WG chairs did organize parallel sessions
  - Selecting next hosts (that could be done by GWIC)

# Topics for today!

- ST 7
- Strategy to get to a future mission
- Strategy for Technology Development Plan
- Support for science/data analysis studies
- Advocacy: Presence at next meetings

# ST7

- Ira

# Options for NASA

Start from current funding profile

- Explorer level contribution to an ESA-led L2 mission
  - Launch 2027, Phase A: ~2019-20
    - Phases C/D cost real money 2023-27
    - Required funding profile depends on NASA contribution (Launcher is needed at the end ...)
  - Still have WFIRST and Explorer higher ranked

Prepare for next Decadal review and win(!):

- NASA-led (or NASA-alone) flagship mission
  - Improved technical readiness
  - Pathfinder will be history by then (**Need access to GRS**)
  - Ground-based community will detect GWs on a regular basis
  - My most optimistic guess here: Phase A: 2021, Launch: + 7 yrs
  - ... and many current missions will have been decommissioned (Chandra, etc., and many communities (X-ray, ...) will 'kill' for that launch spot)

Another economic boom fills the federal budgets ...

# Options for NASA

- Explorer/Probe class level contribution to an ESA-led L2 mission
  - Details (level and type of contribution) would have to evolve over next 3-5 years
- NASA-led (or NASA-alone) flagship mission
- Other options??

Look at impact over next years. Is a decision needed at this stage?

- Do the priorities in science and technology funding depend on it?

# Technologies

## LISA Hardware:

- Phasemeter (includes clock tones, ranging, etc.)
  - The key data generating instrument (Strategic technology at ESA)
- GRS and DRS (includes noise models, auxiliary channels needed to extract the GW signals with high fidelity)
  - The key sensor (Strategic technology at ESA)
- Frequency stabilization (interface with Phasemeter, Laser, and Optical Bench)
- Optical bench (?Strategic technology at ESA?)
- Telescope
- Laser
- Thruster (?Strategic technology at ESA?)
- Photo receiver
- ...

# Options for NASA

## System level studies:

- Lock acquisition studies
- GRS testbeds
- IMS testbeds

## Emerging technologies:

- Digital interferometry

## Science:

- Data analysis techniques
- Parameter estimation
- Event rates

## Schedule:

### ESA option:

- Assume Launch 2027?
- TRL 6 in 2018 for L2??
- When will GRS and IMS designs be frozen?

## Schedule:

### NASA option:

- Assume Launch 2028
- TRL 6 in 2021

# Tech Dev Plan Options

ESA/L2 most centric approach:

1. Telescope (Now)
2. Laser (Now)
3. Thrusters (lifetime testing now)
4. GRS electronic (if possible)

ESA/L2 centric with core technology support approach:

1. GRS testbed (low fidelity, Now)
2. IMS testbed (Continue)
3. Telescope (if possible, enough time 'til 2027)
4. Laser (if possible, enough time 'til 2027)
5. Thrusters (lifetime testing now)
6. Optical Bench (Now)

# Tech Dev Plan Options

NASA centric approach with ESA GRS

1. IMS testbed (continue)
2. GRS testbed (lower fidelity, Now)
3. Optical bench (Now)
4. Telescope (if possible, enough time 'til 2027 if start in 2017)
5. Laser (if possible, enough time 'til 2027 if start in 2017)
6. Thrusters (lifetime testing now)

NASA alone

1. GRS testbed (high fidelity, Now with tons of money)
2. IMS testbed (continue)
3. Telescope (not urgent)
4. Laser (not urgent)
5. Thrusters (lifetime testing now)

# Science/DA support

Justification:

- GW-SAG goals: Need to be able to analyze science output of changing mission designs
- ...

# Advocacy

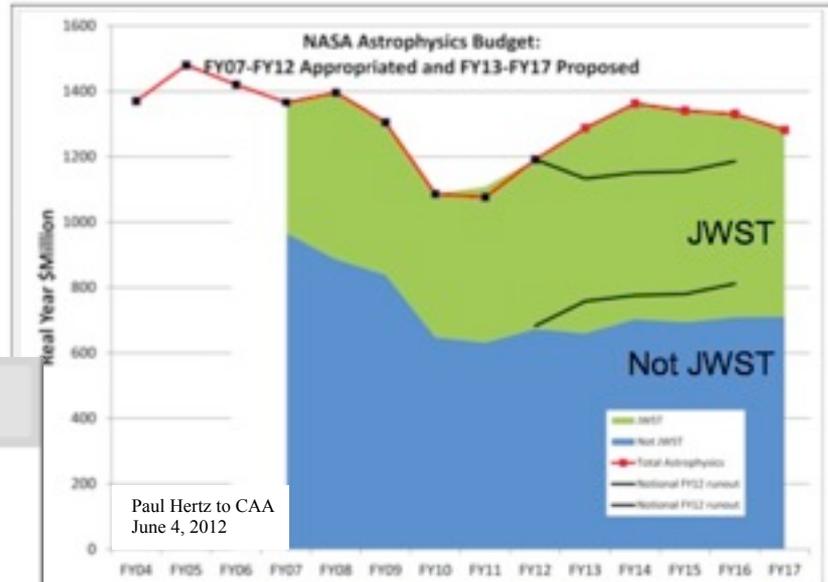
- AAS
  - HEAD
  - APS
  - LISA Symposium
  - LIGO/VIRGO Collaboration meetings??
  - MG
  - GR
  - COSPAR
- 
- Requires some form of funding (part of Research grants or direct support for travel)

# Current situation

- Decadal said some nice words about LISA
  - but worked with obsolete budget:
    - \$600M in FY13
    - \$1B in FY 15
    - \$1.4B in FY 23
  - \$4B over FY13-20 for future missions
  - Does not incl. JWST



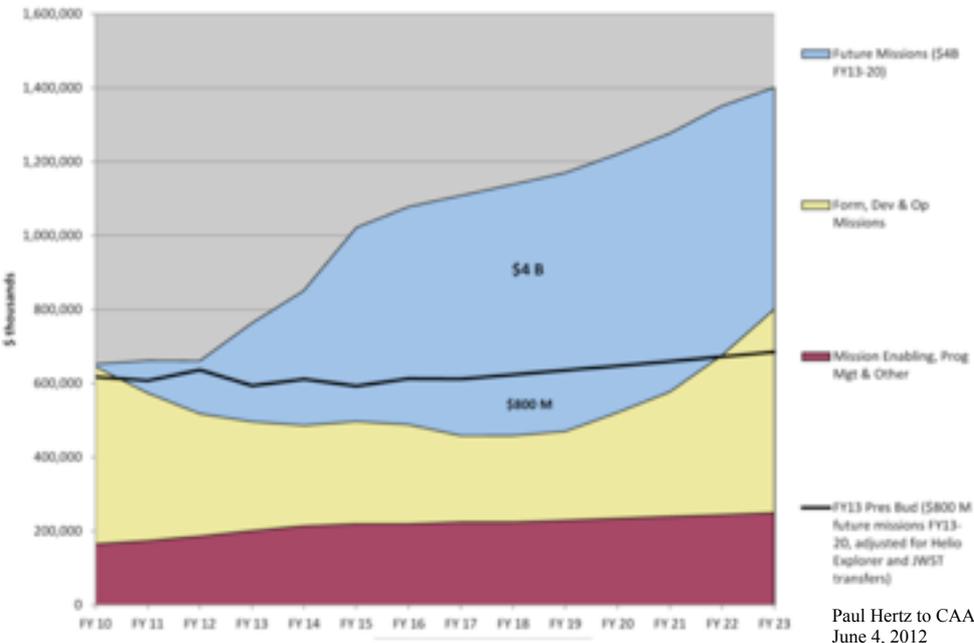
## President's FY13 Budget Request for Astrophysics



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## Changes since the Astro2010 Decadal Survey

Astrophysics FY10 President's Budget (less JWST) and Estimates 2011-2023 as Presented to Decadal Survey



20

Current budget projections: \$600M/year flat

- Support ongoing missions (Chandra, ...), programs (Sofia), and new projects (Euclid, WFIRST, ??)

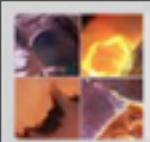
Next large mission:

Enter Phase A: 2018 (~ JWST launch)

Earliest Launch: Phase A + 7yrs = 2025

WFIRST and Explorer ranked above LISA!

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# Euclid – NASA Science Return

Paul Hertz to CAA  
June 4, 2012

- ESA will appoint a NASA-selected member to the Euclid Science Team.
- The Euclid Consortium (EC) will appoint a NASA-selected member to the Euclid Consortium Board and up to 40 NASA-selected members to the Euclid Consortium, commensurate with NASA's hardware contribution to the mission.
- NASA-appointed EC members will have the same data rights as European EC members and will be fully integrated into the Science Working Groups of the EC. The roles and responsibilities of the NASA-appointed EC members will be consistent with ESA's Euclid Science Management Plan and with the Euclid Consortium Science Policies.
- Solicitation for NASA-selected members issued May 23, 2012 as a ROSES amendment.



## EUCLID:

- Selected by SPC in 10/2011
- Launch planned for 2019

Blueprint for ESA-led GW mission?



- Science Definition Team delivered its interim report in July 2011.
  - The report is at: [http://wfirst.gsfc.nasa.gov/science/WFIRST\\_Interim\\_Report.pdf](http://wfirst.gsfc.nasa.gov/science/WFIRST_Interim_Report.pdf)
  - The first Design Reference Mission is a proof of concept that a mission can be constructed that is compliant with the Astro2010 recommendation.
  - Updated guidance given to Science Definition Team December 2011.
  - Second Design Reference Mission will not duplicate capabilities of Euclid, LSST, and JWST in advancing science objectives of WFIRST. Look for cost savings.
  - Final report due June 2012.
- Astro2010 recommended WFIRST as the highest priority large mission.
  - The President's FY13 NASA budget request includes no new large missions; Astrophysics expects none before JWST is successfully completed.
  - FY13 budget request does not support originally planned WFIRST technology development and includes no funding identified for WFIRST.
  - WFIRST will not launch in this decade (2018 + 7 yrs = 2025).
  - Astrophysics does not anticipate budget growth in the foreseeable future.
- NASA is proceeding as follows:
  - Through the Science Definition Team and Design Reference Missions, establish a basis for WFIRST planning.
  - Partner on ESA's Euclid to advance some of the science of Astro2010 and WFIRST.
  - Advance the technology and planning required for WFIRST as the budget allows.
  - Contemplate the use of the NRO telescopes for advancing WFIRST scientific priorities.

# Space Science Explorers

## Explorers/MIDEX



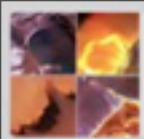
## SMEX



## UNEX & Missions of Opportunity and Internationals



Supporting Heliophysics & Physics & Astronomy



# Explorer Program

- FY13 budget request does not support an AO for both missions and missions of opportunity (MOs) in late CY12.
  - First priority in the Explorer program is to complete Explorers in development: NuSTAR, SXS/Astro-H.
  - Second priority is to downselect and fund the development of one mission and one MO from the projects currently conducting Phase A studies (FINESSE/TESS, GUSSTO/NICER).
  - Third priority is to issue new AOs leading to the development of new missions.
- Funding planned for GEMS will remain in the Explorer Program.
  - Immediately begin the new projects when they are downselected in Spring 2013.
  - Advance the next mission AO.
- The Astro2010 Decadal Survey said to “Enable rapid response to science opportunities; augments current plan by 2 MIDEXs, 2 SMEXs, and 4 MoOs.”
  - “This survey recommends that the annual budget of the astrophysics component of the Explorer program be increased from \$40 million to \$100 million by 2015.”
  - The notional Astrophysics Explorer budget is \$134M in FY15 and \$166M in FY17.
- Astrophysics Division is planning a series of AOs (subject to budget):
  - An AO for a MO with a \$50-60M cost cap in Sep/Oct 2012.
  - An AO for a SMEX in late-2013 with the cost caps and dates TBD by summer 2012.
  - An AO for a EX and MO in 2015.

# Current situation

- NASA: Space-based Gravitational-Wave Observatory (SGO) initiative
  - Search for new concepts
    - Request for Information (RFI) launched

Develop concepts that meet some or all of the scientific objectives of the Laser Interferometer Space Antenna (LISA) Mission **at different cost points:**

- $\leq$  \$300M (Explorer-class)
- $\leq$  \$600M (Probe-class)
- $\leq$  \$1B (for good measure)
- Identify **game-changing technologies**

# Current situation

GW-Community:

- Large ground-based community
  - Advanced LIGO/VIRGO/KAGR
    - India as a potential new big player
  - Still growing on global scales
    - Maybe reaching saturation in the US and Europe
- Small space-based community
  - Lost the LIST, community shrinks
  - Need to grow our 'space community' again
  - **People have to see that there is a future in LISA**