GW-SAG Status and Plans

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AAS Meeting

Long Beach 2013
GW-SAG

- GWs around the world:
  - Non-space based detectors
  - Summarize GW Study in US
  - Presentation on Monday
  - eLISA
  - NASA plans/path forward
- Role and Organization of GW-SAG
GW-Detection schemes/Detectors

**Inflation Probe**
- Polarization in u-Wave Background
- Source: Density Fluctuations Gravitational Waves

**Pulsar Timing**
- IPTA
- Sources: Background from MBH-binaries
- Reach critical sensitivity: 2016

**LISA**
- Sources: SMBH mergers, EMRIs, Galactic binaries
- Guaranteed signals
- Largest SNR
- Most Science

**LIGO**
- LIGO, VIRGO, KAGRA, GEO
- Sources: NS/BH mergers, Supernovae, Pulsars, ...
- Reach critical sensitivity: 2016

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**f [log Hz]**

-18  -15  -9  -6  -5  -1  1  4
GWs around the world

- Advanced LIGO

Construction on schedule, science operation expected to begin 2015

- ~95% of hardware built, installation ~55% complete

- At least one of almost all kinds of hardware installed, tested, functioning

1 LIGO-PAC Meeting Nov. 2012
GWs around the world

- Advanced LIGO/VIRGO
  - will likely detect GWs from NS and solar mass BH mergers this decade!
- KAGRA (Japan)
  - working on a cryogenic underground detector
- GEO
  - currently in Astrowatch
  - later: HF-GEO, focus on high frequency signals
- LIGO-India
  - Approval expected early 2013
  - Planned to reach aLIGO sensitivity in 2021

Summary:
Major progress towards first detections of GWs from low mass binaries and other potential high frequency sources
Pulsar Timing

- International Pulsar Timing Array
  - NanoGrav
  - EPTA (Europe)
  - Parkes Pulsar Timing Array
- Looking for GWs from massive black hole binaries long before the merger
- Current best estimate
  - Detection of stochastic GWs likely between 2016 and 2024

Credit: Justin Ellis and Xavier Siemens for the NANOGrav Collaboration
GW-Detection schemes/Detectors

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GW Study

Goals

• Mission concepts at lower cost points
• Explore how architectural choices affect science, risk and cost
• Identify key enabling technologies

General findings (short version)

• Can get some science done at reduced cost
• Eliminating a measurement arm reduces costs modestly, reduces science and increases mission risk.
• Scientific performance decreases far more rapidly than cost.
• No new technology magically appeared that reduces the cost significantly!
• Cost will be >$1B

Summary: LISA-like mission promises most science with lowest risk and cost

The final study report can be downloaded from:
http://pcos.gsfc.nasa.gov/studies/gravitational-wave-mission.php
eLISA

- evolved LISA
- European group prepares proposal for ESAs L2/L3-call
- Call expected after SPC meeting in February

Rules of call still evolving
- Might be similar to L1
- Boundary conditions for L1:
  - ESA led
  - about 1B€ cost cap
- International partners:
  - not mission critical
  - improve science
  - < 20% of total cost
eLISA

- 2-arm mission
- Drift away orbit
- 2 year science operation

Roadmap for LISA (from eLISA Consortium)
- Preselection of LISA for L2 in 2013/14
- Confirmation after successful LISA Pathfinder (Launch 2015)
- Build EQM of complex payload (2016–2020)
- Start industrial implementation in 2020
- Launch in 2028

Figure 1. The eLISA gravitational wave observatory concept: Three spacecraft in orbit around the Sun, each containing two Gravitational Reference Sensors, linked by a laser interferometer.
NASA Implementation Plan

LISA/LISA-like GW mission:
- Candidate large mission next decade
- Candidate for international partnership (eLISA)
- Technology Development over the next years

GWSAG and eLISA: Discussions with NASA and eLISA Consortium:
- What could NASA contribute?
  - 3rd arm, lifetime, more laser power, ...
  - Everything on board is mission critical
- How to prioritize technology development (Monday session)

When would we need to join?
Does the EQM freezes the technologies and suppliers?
NASA Implementation Plan

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Best way forward will depend on L2-call: ESA-Conditions for an international partner?
Organization of GW-SAG:

- Advocacy/Outreach: Scott Hughes
- Science: Neil Cornish
- Organization and Technology: Guido Mueller (Chair)
Organization of GW-SAG

Advocacy/Outreach: Scott Hughes et al.

- Organize presence at meetings
  - Poster session at AAS
  - Session at HEAD with European guest speakers
  - APS Meeting:
    - Joint GGR-DAP session on multimessenger astronomy
    - Focus session of Gravitational wave missions in space

- Plans for Articles for newsletters (LIGO Magazine, ...)

- Follow up on LISA-related scientific papers

- Online Blog
  - [http://gravitytalking.wordpress.com/](http://gravitytalking.wordpress.com/)

- ...

Sunday, January 6, 13
Organization of GW-SAG

Science: Neil Cornish et al.

- **Science capabilities of LISA-like missions**
  - Detection rates
  - Parameter estimation
    - Masses, spins, sky localizations, ...

- **Science case for white papers/yellow books/proposals**

- **Science WGs (match eLISA Science WGs)**
  - Ultra Compact Binaries (Shane Larson)
  - Massive Black Holes (Emanuele Berti)
  - Extreme Mass Ratio Inspirals (Scott Hughes)
  - Testing Fundamental Physics (Nicolas Yunes)
  - Cosmology (Daniel Holz)
  - Data Analysis and Mock LISA Data Challenges (Michele Vallisneri)

Currently unfunded work ...
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Open to the public!
Contact us!
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- Close Collaboration with the former LISA Team
  - led by Robin ‘Tuck’ Stebbins at GSFC
  - Support writing of Technology Development Plan

- In Contact with Paul Hertz and others
  - Discuss current options and future opportunities
    - eLISA, LTP

- Interact with eLISA Consortium
  - Direct contact with eLISA leadership
  - 1st eLISA meeting in October 2012 in Paris
  - ‘Science of measurement’ WG meeting January 28-29 in Hannover
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The best path forward is not obvious!
But we keep on going!
what keeps us going?
what keeps us going?

Fantastic Science
what keeps us going?

GW Detection by LIGO and IPTA

Fantastic Science
what keeps us going?

GW Detection by LIGO and IPTA

Fantastic Science

Pathfinder Success
what keeps us going?

GW Detection by LIGO and IPTA

Fantastic Science

Low Risk ratings

Pathfinder Success
what keeps us going?

GW Detection by LIGO and IPTA

Fantastic Science

LISA will come soon

Low Risk ratings

Pathfinder Success
BACK UP
LISA Pathfinder:
- Paul McNamara reported early November in GWSAG telecon

**Status [1]**

- Spacecraft integration has been put on hold awaiting delivery of the payload and cold gas thrusters
  - Payload delivery: May 2014
  - Cold gas thruster delivery: Dec 2013

- Spacecraft environmental testing (1st Phase) complete
  - Magnetic test
  - Separation shock
  - Vibration
  - Thermal vacuum

**Status [2]**

- The payload is on the critical path
  - Critical path item is the inertial sensor heads

- Project is in hibernation
  - Hibernation expected to last until end 2013

- System level performance surpasses requirements on every level

- Launch scheduled for Jan 2015

Launch: January 2015