ESA’s Gravitational Observatory Advisory Team (GOAT)

Robin Stebbins, GSFC
Presentation to the Astrophysics Subcommittee
Telecon, 21 July 2015
Topics

• Basics
  • Terms of Reference (Charge)
  • Membership
  • Term and Meetings

• Activities
  • Alternate technical approaches
  • Technology development
  • Schedule
  • Scientific performance

• Products
  • Internal documents
  • Intermediate report (15 June 2015)

• Future activities
The Basics: Terms of Reference, Membership, Meetings
Terms of Reference

“To evaluate and recommend on possible scientific and technical approaches for a gravitational wave observatory envisaged for a planned launch date in 2034.”

• The objectives of the committee are:
  • To identify promising technologies for the detection of gravitational waves from space and their use as ‘astrophysical messengers’ in the context of L3;
  • To recommend on the technological activities and milestones needed to develop and eventually choose between the most promising technologies;
  • To identify possible scientific and technological milestones that should be achieved (either by ESA or independently) and the relevant decisions linked to these milestones;
  • To engage with the gravitational wave scientific community to ensure that the most recent information and promising approach are considered.
Membership

- Michael Perryman (University College Dublin), Chair
- Pierre Binetruy (AstroParticule et Cosmologie, Paris)
- Philippe Bouyer (Laboratoire Photonique, Numérique et Nanosciences (LP2N))
- Michael Cruise (University of Birmingham)
- Reinhard Genzel (Max Planck Institüte für Extraterrestrische Physik, Munich)
- Mark Kasevich (Stanford University)
- William Klipstein (Jet Propulsion Laboratory)
- Guido Müller (University of Florida)
- Benard Schutz (Albert Einstein Institute, Golm and University of Cardiff)
- Stefano Vitale (Università degli Studi di Trento)

Observers
- Masaki Ando (JAXA)
- Robin Stebbins (NASA)

ESA support
- Luigi Cacciapuoti
- Fabio Favata
- Martin Gehler
- Oliver Jennrich
- Frédéric Safa
Meetings and Term

• Meetings to date
  • Kick-off telecon – 26 September 2014
  • GOAT #1 – 14-15 October 2014, ESA Headquarters, Paris
  • GOAT #2 – 8-9 December 2014, ESA Headquarters, Paris
  • GOAT #3 – 25-26 March 2015, ESA Headquarters, Paris
  • GOAT #4 – 1-2 June 2015, ESA Headquarters, Paris

• Scheduled future meetings
  • GOAT #5 – 16-17 September 2015, ESTEC, Noordwijk NL
  • GOAT #6 – 15-16 December 2015, ESA Headquarters, Paris

• Term
  • Mid 2016 with report on LISA Pathfinder
GOAT Activities
Initial Range of Activities

- Technical feasibility: are there fundamental issues
- Science goals: configuration trade-off
- Data analysis: Are there risks/problems?
- System view
- Technology: Laser vs atom interferometry, immature items
- Partners
- Cost: recurring costs, descope options
- Schedule: establish a consolidated timeline
Reported Activities (1/4)

• Science objectives
  • Compiled an expanded statement of target science

• Detection technologies
  • Compiled a long list from the literature
  • Only 2 detection technologies address the science recommended by the Senior Selection Committee
  • Laser interferometry responds to the science goals set out in the 2013 report of the Senior Science Committee, and is sufficiently well advanced to offer a realistic prospect of implementation according to the 2034 launch schedule.
  • Committee is still seeking a full mission proposal based on atom interferometry.
Reported Activities (2/4)

• Scientific performance trade-off: assess the science that can be performed with a particular architecture.
  • 24 mission configurations
    • 2 or 3 measurement arms
    • 2 or 5 years of science observations
    • LISA or 10X worse/LISA Pathfinder low frequency acceleration noise
    • 1, 2 or 5 million kilometer arm lengths
  • Performed by European researchers, with some input from US colleagues

• Data analysis
  • No fundamental or conceptual issues with the data analysis. Recommend renewed effort, in part, because of impact on mission design
Reported Activities (3/4)

• Technology development
  • Compiled all required technology developments
  • Technology challenges are significant, but should not be overstated. LPF will retire many of the space-specific risks.
  • Recommend four high priority technology development activities for immediate start

• Cost
  • European cost studies suggest a budget of 1.0-1.2 B€, only weakly dependent on system architecture.

• Schedule (next chart)
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GOAT Products

- Internal documents
  - Scientific trade-off report
  - Technology development spreadsheet
  - List of detection technologies
  - Propulsion technologies summary
- Intermediate GOAT report
  - Public document, released 15 June 2015
  - Distributed to ESA advisory structure and the Science Programme Committee
  - Major findings summarized in previous 4 charts
  - Used to notify European national agencies that “expressions of interest” in the mission will be sought by ESA Headquarters at the “end of the summer.”
Future GOAT Activities

• Complete assessment of scientific performance as a function of mission configuration
• Formulating some considerations on configuration choices to balance cost and scientific performance
• Advancing the definition and scope of the Payload Engineering Model
• Assessing the technical and scientific risks of LPF
• Summarizing the technologies validated by LPF
• Detailing any fundamental risks associated with gravitational wave detection
• Reviewing the prospects and status of atom interferometry
• Responding to specific requests on costing from ESA Executive or its advisory committees
Status of LISA Pathfinder (1/2)

• Launch date
  • Official launch contract puts launch between 15 November and 14 December 2015
  • Target day to be determined in mid-August. November 26\textsuperscript{th} is favored.

• Spacecraft/payload/propulsion module/launch adaptor integration complete.

• On schedule to pack for shipping to launch site (Kourou) on August 18\textsuperscript{th}

• Expect to store for 6 weeks

• Operations should start at the end of January 2016.
Status of LISA Pathfinder (2/2)
Summary

GOAT has made significant progress on several topics.

• Laser interferometry is the only detection technology shown to be viable, but the search isn’t over.

• Science trade-offs have been investigated.

• Technology recommendations enable ESA and the member states to start investments as early as the end of the year.

• No fundamental technical obstacles found, in either technology or data analysis.

• A preliminary schedule has been developed, but remains under study.

• The concept of an engineering payload model remains problematic.