Listening to the Universe with eLISA: A Gravitational Wave Detector in Space

EPS HEP Stockholm
19 July 2013
Prof. Dr. Karsten Danzmann
Gravitational Waves

– Distortions of Space and Time that propagate at the speed of light!
Gravitational Waves

• Predicted by Einstein more than 90 years ago

• No direct detection yet

• Indirect proof of existence via energy loss of

  Binary Pulsar PSR1913+16

  (Hulse-Taylor)
Hulse-Taylor Binary Pulsar

Einstein’s prediction

Nobel prize for physics 1993
The Effect is small!

- Supernova in local group of galaxies
  ⇒ Squeezing of space by $10^{-21}$

  ⇒ 1 km baseline changes by 1/1000 of a Proton diameter ($10^{-18}$ m = 1 Attometer)!

  ⇒ For a few milliseconds!
Original Interferometer of Michelson and Morley 1887

- Sensitivity 1887:
  \[ \Delta \ell = 600 \text{ pm} = 0,000,000,000 \text{ m} \]

- Laser interferometer today:
  \[ 0,000,000,000,000,000,000,000 \text{ m/}\sqrt{\text{Hz}} \]
GEO600

- German-British collaboration, location Hannover / Germany

- Michelson Interferometer with power and signal recycling
World Wide Laser Interferometric Gravitational Wave Detector Network

- LIGO
- GEO600 (under construction)
- KAGRA (future)
- LIGO – India?
GEO600, Virgo, LIGO Sensitivities
Largest Dedicated Computer Cluster in the World for GW Data Analysis at AEI

LIGO Hanford (USA)

GEO600 operated by AEI

LIGO Livingston (USA)

VIRGO (Pisa)
Astrowatch for GEO600 until 2016

- **LIGO and Virgo** offline for upgrading
- Back online 2016, design sensitivity 2019

- **GEO600** taking data 24/7 while others are down
- Occasional interruptions for commissioning and upgrades
- Will continue data taking until Advanced LIGO and Advanced Virgo are more sensitive in maybe 2017/8
- Then upgrade GEO600 beyond GEO-HF
The Gravitational Wave Spectrum

Wave Period

Frequency (Hz)

AGE OF THE UNIVERSE

YEARS

HOURS

SECONDS

MSEC

10^{-16} 10^{-14} 10^{-12} 10^{-10} 10^{-8} 10^{-6} 10^{-4} 10^{-2} 1

DETECTORS

CMBPOL

polarization map of cosmic microwave background

precision timing of millisecond pulsars

ASTROD

laser tracking of drag-free proof mass in spacecraft orbiting the sun

LISA

BIG BANG OBS

DECIGO

GEO, LIGO, VIRGO, TAMA

laser interferometers on Earth (also bar detectors)
LISA

Laser Interferometer Space Antenna

3 Satellites
Million km arms
50 Million km behind Earth
LISA: A Mature Concept

- After first studies in 1980s, M3 proposal for 4 S/C ESA/NASA collaborative mission in 1993
- LISA selected as ESA Cornerstone in 1995
- 3 S/C NASA/ESA LISA appears in 1997
- Baseline concept unchanged ever since!
Merger Signals far above Noise!

- Simulated LISA data stream,
  - $10^5M_\odot$ BH binary merger at $z=5$,
    including instrumental noise (SNR~500)

Baker et al. 2006
LISA measures absolute distances

- Almost all LISA sources are binary systems.
- A system that radiates GWs strongly will “chirp” up in $f$.
- **Standard sirens**: absolute luminosity distances to chirping binary systems can be derived *directly* from

\[
\text{Distance} \approx c \frac{1}{\text{frequency}^2 \times t_{\text{chirp}} \times \text{amplitude}}
\]

- Works for *any* chirping binary (mass ratio, eccentricity, spins)
- Distances $D_L$ given in light-seconds: no calibration needed.
- Clean systems: high accuracy, few systematic errors.
- Completely independent of other astronomical distance ladders
- If we assume a cosmology, $D_L \Rightarrow z$ for each observed system.
- With a population, we can measure $H_0$, $w$ even without $z$’s.
Accuracy of $D_L$: weak lensing

- Babak et al (2011)
- Shapiro et al (2009)
Cosmology with standard sirens

- With luminosity distances, LISA can provide accurate and independent measurements of $H_0$ and $w$.
  - Using EMRIs, without identifications, LISA can determine $H_0$ to $\pm 0.4\% = \pm 0.3$ km s$^{-1}$ Mpc$^{-1}$ after just 20 EMRI detections: ~3 months LISA data.
    (MacLeod & Hogan, PRD, 2008; SDSS)
    Today (WMAP) $\pm 1.2$ km s$^{-1}$ Mpc$^{-1}$.
  - Using massive mergers out to $z=3$, again with no identifications, LISA can (in 3 years) determine dark energy equation of state parameter $w$ to $\pm 2-4\%$.
LISA Pathfinder

• Testing LISA Technology in Space!
The Spacecraft

- Waiting for a launch in 2015!
Launch in 2015

Lagrange Point L1
But then in March 2011...

Published online 22 March 2011 | Nature 471, 421 (2011) | doi:10.1038/471421a

News

Europe makes do without NASA

US budget crisis forces European Space Agency to abandon plans for joint mission.

The European Space Agency (ESA) is pushing ahead without NASA support for its next big science mission, as the ongoing US budget crunch and competing priorities impose serious constraints on the US space agency (see Nature 471, 278; 2011). ESA last week told leaders of three large, or 'L-class', missions that are competing for funding to revise their proposals by leaving out the substantial US contribution that had previously been assumed.

"The decision was made very reluctantly," says David Southwood, director of science and robotic exploration at ESA. "NASA could not meet our timetable to launch."

Related stories

- China hopes research centre can quell food-safety fears
  22 April 2011

- US Mars mission takes pole position
  08 March 2011

- ESA on countdown to flagship mission selection
LISA Redefinition Study for L1

• Redesign for ESA-only mission

• Cost-cap for ESA cost at 850 M€ plus member state contributions around 200 M€

- Build on LISA Pathfinder hardware
- Shorter arms, smaller telescopes, simpler orbits, less mass
- Can use cheaper launcher

→ Mission Concept called NGO (eLISA)

→ eLISA: evolving LISA
→ NGO: specific incarnation with 2 arms for ESA L1 selection!
Payload size

- OB diameter drives S/C height
- Max OB diameter allowed by current dual Soyuz accommodation is 350mm
- This is realistic, implies use of both OB sides
Re-use LPF Spacecraft

- Same spacecraft bus for all 3 spacecraft, recurring costs
- Upper deck to accommodate micro-propulsion system FEEP/cold gas/miniRits

<table>
<thead>
<tr>
<th></th>
<th>Mother</th>
<th>Daughter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sciencecraft Dry Mass</td>
<td>625 kg</td>
<td>497 kg</td>
</tr>
<tr>
<td>Propulsion Module Dry Mass</td>
<td>212 kg</td>
<td>212 kg</td>
</tr>
<tr>
<td>Total Dry Mass, including 20% System Margin</td>
<td>1003 kg</td>
<td>849 kg</td>
</tr>
<tr>
<td>Wet Mass</td>
<td>1658 kg</td>
<td>1578 kg</td>
</tr>
<tr>
<td>Power Required, including 20% System Margin</td>
<td>765 W</td>
<td>658 W</td>
</tr>
</tbody>
</table>
NGO offers revolutionary science

- **Massive BHs** ($10^5$--$10^7 M_\odot$)
  - Measurement of mass at $z = 1$ to ±0.1%, spin $a/M$ to ±0.01.
  - Mass function, central cluster of black holes in ordinary galaxies to $z = 0.5$.

- **Evolution of the Cosmic Web at high redshift**
  - Observation of objects before re-ionisation: BH mergers at $z >> 10$.
  - Testing models of how massive BHs formed and evolved from seeds.

- **Compact WD binaries in the Galaxy**
  - Catalogue ~3000 new white-dwarf binary systems in the Galaxy.
  - Precise masses & distances for dozens of systems + all short-period NS-BHs.

- **Fundamental physics and testing GR**
  - Ultra-strong GR: Prove horizon exists; test no-hair theorem, cosmic censorship; search for scalar gravitational fields, other GR breakdowns.
  - Fundamental physics: look for cosmic GW background, test the order of the electroweak phase transition, search for cosmic strings.

- **Europe can take ownership of this new science:** only Europe has the technical expertise to put a mHz GW observatory into space!
eLISA Science and Astronomy

• Cosmology
  – Expansion of universe and Dark Energy equation of state
• Black Holes
  – Evolution, seismology and bothrodosy
• Precision tests of strong gravity
  – No-hair theorem
• Galaxy mergers
  – History and evolution
• **Structure of galaxy**
  – Complete WD mapping and stellar evolution
• Helioseismology
  – Solar g-modes
• Big Bang
  – Primordial GW radiation
Galactic binaries: relevance

- Probes binary evolution
  - Common envelope

- Type Ia Supernovae
  - Same populations

- Galactic populations/structure
  - Tracers of star formation

- Binary interactions
  - Mass transfer/tides
eLISA: 100 Million White Dwarf Binaries

- eLISA will “see” every binary system in the Galaxy that has a period < 2 hr
- Several 1 000 resolvable in 2 yr
- Synergy between eLISA and GAIA:
  - eLISA polarisation measurement gives inclination of orbital plane
  - eLISA gives accurate distances to and masses of WD/WD binaries whose orbits show effects of gravitational radiation reaction
Gravitational Waves from WD Binaries

- Unresolved double WD background
- Above and at high $f$ systems resolved: $\sim 3,000$ of both double WD and AM CVns

Nelemans et al. 2004
eLISA Science and Astronomy

• Cosmology
  – Expansion of universe and Dark Energy equation of state
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• Precision tests of strong gravity
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  – Solar g-modes
• Big Bang
  – Primordial GW radiation
Sensitivity and BH Science

- Inspirals
  - BH binary
  - EMRI
- Galactic binaries
  - resolved
  - verification
  - confusion

Characteristic strain amplitude vs. frequency (Hz)
- $M_{\text{tot}} = 10^7 M_\odot$
- $M = 10^6 M_\odot + 10 M_\odot$
Binary Black Holes at large Redshift!

Contours of SNR, equal mass merger (optimal)
Almost all BBHs cross eLISA band
Trace Galaxy Evolution through Black Hole Mergers

- Hierarchical structure formation: many galaxy mergers
- Most galaxies have BH in center: \( \rightarrow \) Many BH mergers
- Strong eLISA sources
eLISA Black Hole Physics at high SNR

- BBH rest mass $10^4 – 10^7$
- Out to redshift $z \approx 7$
- Redshifted mass to 0.1%-1%
- Absolute spin to 0.01-0.1
- Luminosity distance $1 – 50\%$
- Sky location $3^\circ - 10^\circ$
LISA Science and Astronomy

- **Cosmology**
  - Expansion of universe and Dark Energy equation of state
- **Black Holes**
  - *Evolution, seismology and bothrodesy*
- **Precision tests of strong gravity**
  - No-hair theorem
- **Galaxy mergers**
  - History and evolution
- **Structure of galaxy**
  - Complete WD mapping and stellar evolution
- **Helioseismology**
  - Solar g-modes
- **Big Bang**
  - Primordial GW radiation
What Happens at the Edge of a Black Hole?

**X-Ray Spectroscopy**
- Japan-US ASCA satellite discovered iron lines near the event horizon of a black hole
- Line exhibits a strong redshift and provides a unique probe of the inner regions of black holes

**Gravitational Radiation**
- Black hole binaries produce gravitational waves in all phases of their evolution
- Test of GR in all three phases
At the Edge of a Black Hole

• Capture by Massive Black Holes
  – Compact object inspiral into massive black hole (MBH),
  – GWs map space-time geometry with superb precision
  – Allows tests of many predictions of General Relativity including the “no hair” theorem

GW from Splurge into BH at 1 Gpc

$h_x$

$h_+$

$S$ Hughes (CalTech)
Precision Bothrodesy (BH Science) with GWs

(Ancient Greek: Bothrod = sacrificial pit, well)

Here: 10 M☉ BH into 10^6 M☉ BH at 1 Gpc; large spin [Phinney, Finn & Thorne]

1 yr before plunge: 
r = 6.8 r_{\text{Horizon}}
185,000 cycles left, 
S/N ~ 100

1 mo before plunge: 
r = 3.1 r_{\text{Horizon}}
41,000 cycles left, 
S/N ~ 20

1 day before plunge: 
r = 1.3 r_{\text{Horizon}}
2,300 cycles left, 
S/N ~ 7
Orbits and spiral-in of small bodies around spinning Black Holes

(Extreme Mass Ratio Inspirals, EMRIs)

Spiral-in and Circularization
(GW energy and angular momentum losses)
Slow!

Peribothron precession

Orbit plane precession
spin–orbit; L-T(Lense-Thirring)
Frequencies sweep and shift slowly as compact object spirals in, mapping space-time outside the horizon.

⇒ Like a Geodesy satellite mapping Geopotential!
⇒ GRACE for Black Holes!
Extreme Mass Ratio Inspirals

• SNR 20 up to $z \approx 0.7$ for $10^5$-$10^6 \, M_\odot$
• Dozens of events
• Mass, spin to 0.1% – 0.01 %
• Quadrupole moment to $< 0.001 \, M_\odot^3 G^2 / c^4$
Symmetry breaking after Big Bang – Cosmic Strings

\[ h^2 \Omega_{gw} \]

- pulsars
- LIGO
- NGO
- aLIGO

- \( G\mu = 10^{-11}, \alpha = 0.1 \)
- \( G\mu = 10^{-11}, \epsilon = 10^{-8} \)
- \( G\mu = 10^{-12}, \alpha = 0.1 \)
NGO: Revealing a Hidden Universe

Presentation to SSAC, Paris, April 2, 2012

Bernard Schutz and Karsten Danzmann
for the NGO Study Team
SSAC Recommendation

- EUROPEAN SPACE AGENCY
- SPACE SCIENCE ADVISORY COMMITTEE (SSAC)
- Recommendation on the selection of the L1 mission
- At its 138th meeting held at Paris on April 3-4 2012, the SSAC met to recommend the mission to be selected for the L1 launch slot of the Cosmic Vision Programme. The SSAC considered the three missions ATHENA, JUICE, and NGO.
- The SSAC carefully considered both the scientific and programmatic aspects concerning the three mission candidates, including their scientific value and the overall impact on the Science Programme.
- After an extensive discussion the SSAC came to a consensus and recommends the JUICE mission to be selected as the L1 mission leading to a launch in 2022.
- The SSAC unanimously recognized the high science value of NGO and therefore recommends continuing the necessary technology activities to enable a gravitational wave observatory to be a strong candidate for the next launch slot.
- The SSAC also recognized the science value of ATHENA and therefore recommends continuing the technology activities for enabling an X-ray observatory to be a strong candidate for the next launch slot.
JUICE is Europe’s next large science mission

2 May 2012
PR 13 2012 - Jupiter’s icy moons are the focus of Europe’s next large science mission, ESA announced today.

The Jupiter Icy moons Explorer – JUICE – was selected over two other candidates: NGO, the New Gravitational wave Observatory, to hunt for gravitational waves, and ATHENA, the Advanced Telescope for High-Energy Astrophysics.

JUICE is the first Large-class mission chosen as part of ESA’s Cosmic Vision 2015-2025 programme.

It will be launched in 2022 from Europe’s spaceport in Kourou, French Guiana, on an Ariane 5, arriving at Jupiter in 2030 to spend at least three years making detailed observations.
The high scientific value of both NGO and ATHENA was also recognised by the Science Programme Committee in today’s decision, and technology activities are planned to continue, enabling the missions to be considered as candidates for future launch opportunities. A second Call for Large Missions is expected in 2013.
NGO Consortium (NC)
maintained as eLISA Consortium
eLISA Technology Roadmap 2012-2015

Document No. LISA-AEI-RP-6001
Report

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Michael Tröbs, AEI Hannover

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Karsten Danzmann, AEI Hannover
Domenico Giardini, ETH Zürich
Allan Hornstrup, DTU Copenhagen
Philippe Jetzer, University of Zürich
Alberto Lobo, IFEC Barcelona
Gijs Nelemans, Radboud University Nijmegen
Bernard Schutz, AEI Potsdam
Tim Sumner, Imperial College London
Stefano Vitale, University of Trento
Harry Ward, University of Glasgow
ESA appoints TASAT

• Technology Activities Science Advisory Team for Gravitational Wave Missions
  – Chair: Oliver Jennrich
  – Members: Pierre Binetruy, Karsten Danzmann, Stefano Vitale, Harry Ward

I have the pleasure of inviting you to become a member of the Technology Activities Science Advisory Team for a Gravitational Waves mission (GW-TASAT).

Yours sincerely,

Ana M. Heras
Science Coordination Office
Directorate of Science and Robotic Exploration
ESA ESTEC
The Science Instrument

- 2 on Mother
- 1 each on Daughter
Germany: Phasemeter

• Some heritage from LISA Pathfinder
• For LISA, PM was NASA-provided item
• Laboratory experiments in Europe
• German/Danish team
• Performance well in spec

• German funding available for complete unit
• Support from Denmark: few FTEs/y TBC
  – Treated as contingency
France: Data Center at APC

- Data storage, software provision and support
- Data input from ESA SOC
- Timely provision of Level 2 and 3 data
  – to SOC and NC national data centers

- Already used for Pathfinder
- CNES funds Level 0 study for LISA
Italy: GRS Lead
LISA Pathfinder Heritage
UK: Charge Management System

- LISA Pathfinder Heritage
  - New developments: UV diodes
  - ESA TRP ongoing
UK: Optical Bench

- LISA Pathfinder Heritage
Switzerland: GRS Front-End Electronics

- LISA Pathfinder heritage
  - Needs delta qualification for lower frequencies
  - ESA TRP ongoing
Switzerland: Caging Mechanism

- LISA Pathfinder Heritage
- After successful LPF flight available as is
Spain: Diagnostic System

- LISA Pathfinder Heritage
  - Needs more channels for eLISA
Call for White Papers for the definition of the L2 and L3 missions in the ESA Science Programme

05 Mar 2013

The Director of Science and Robotic Exploration intends to define, in the course of 2013, the science themes and questions that will be addressed by the next two Large (L-class) missions in the Cosmic Vision 2015-2025 plan, "L2" and "L3", currently planned for a launch in 2028 and 2034, respectively. This process starts with a consultation of the broad scientific community, in the form of the current Call, soliciting White Papers to propose science themes and associated questions that the L2 and L3 missions should address. The submission deadline for White Papers is 24 May 2013, 12:00 CEST (noon).
<table>
<thead>
<tr>
<th>Activity</th>
<th>Date</th>
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<tbody>
<tr>
<td>Release of Call for White Papers</td>
<td>March 5, 2013</td>
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<tr>
<td>Deadline for Call for White Papers</td>
<td>May 24, 2013</td>
</tr>
<tr>
<td>Invitation to spokespersons to the workshop</td>
<td>July 8, 2013</td>
</tr>
<tr>
<td>Open workshop</td>
<td>September 2-3, 2013 (TBC)</td>
</tr>
<tr>
<td>Director’s proposal to the SPC concerning the science themes for L2 and L3</td>
<td>Late October 2013</td>
</tr>
<tr>
<td>Selection of the science themes for L2 and L3 by the SPC</td>
<td>November 13-14, 2013</td>
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</table>
ESA’s L2 Mission

• Call for Science Themes 2013
• Selection of 2 Themes in Nov 2013
• Call for L2 Mission mid-2014
• Assessment study during 2015
• LISA Pathfinder launch 2015
• Selection of L2 at Feb 2016 SPC meeting

→ LISA hard to beat after successful Pathfinder launch
Call for White Papers for the definition of the L2 and L3 missions in the ESA Science Programme

5 March 2013

EXECUTIVE SUMMARY

The Director of Science and Robotic Exploration intends to define, in the course of 2013, the science themes and questions that will be addressed by the “L2” and “L3” missions. These are the two Large missions in the Cosmic Vision plan currently planned for a launch in 2028 and 2034, following the already selected L1 mission JUICE, to be launched in 2022. This process will start with a consultation of the broad scientific community, in the form of a “Call for White Papers”, solicited through the present document. By means of the White Papers, the scientific community is invited to submit proposals for science themes and associated questions that should be addressed by the L2 and L3 missions.
Among the, roughly, 1000 scientific supporters of the Gravitational Universe science theme, are

Gerardus ‘t Hooft Utrecht University (Netherlands), Barry Barish Caltech (United States), Claude Cohen-Tannoudji College de France (France), Neil Gehrels NASA Goddard Space Flight Center (United States), Gabriela Gonzalez LIGO Scientific Collaboration Spokesperson, LSU (United States), Douglas Gough Institute of Astronomy, University of Cambridge (United Kingdom), Stephen Hawking University of Cambridge, DAMTP (United Kingdom), Steven Kahn Stanford University/SLAC National Accelerator Laboratory (United States), Mark Kasevich Stanford University, Physics Dept. (United States), Michael Kramer Max-Planck-Institut fuer Radioastronomie (Germany), Abraham Loeb Harvard University (United States), Piero Madau University of California, Santa Cruz (United States), Luciano Maiani Università di Roma La Sapienza (Italy), John Mather NASA Goddard Space Flight Center (United States), David Merritt Rochester Institute of Technology (United States), Viatcheslav Mukhanov LMU München (Germany), Giorgio Parisi Universita di Roma la Sapienza (Italy), Stuart Shapiro University of Illinois at Urbana-Champaign (United States), George Smoot Universite Paris Diderot (France), Saul Teukolsky Cornell University (United States), Kip Thorne California Institute of Technology (United States), Gabriele Veneziano Collège de (France) (France), Jean-Yves Vinet Virgo Collaboration Spokesperson, OCA Nice (France), Rainer Weiss MIT (United States), Clifford Will University of Florida (United States), Edward Witten Institute for Advanced Study, Princeton (United States), Arnold Wolfendale Durham University (United Kingdom), and Shing-Tung Yau Harvard University (United States).
Von: Fabio Favata <Fabio.Favata@esa.int>
Betreff: Invitation to present your White paper to the L2L3 workshop
An: Karsten Danzmann <Karsten.Danzmann@aei.mpg.de>

Dear Karsten,

first of all thanks for having submitted a response to the Call for White Papers that we issued for the definition of the science themes for the future "L2" and "L3" Large missions in the ESA Scientific Programme.

As you know, the Director of Science and Robotic Exploration, Dr. Alvaro Gimenez, has invited a Senior Survey Committee chaired by Dr. Catherine Cesarsky to advise him on the selection of the science themes for L2 and L3. A key step in the selection process is the public presentation of a selected number of White Papers at an open workshop in Paris on September 3 and 4. At this occasion, a number of authors will be invited to present their proposed science theme in front of the Senior Survey Committee and of the broad scientific community.

On behalf of Dr. Catherine Cesarsky I would like to invite you to present the White Paper "The Gravitational Universe" for which you have been designated as spokesperson. You
Strawman Mission Scenario

• Go with L1 NGO as baseline
  – L2 Cost envelope is (1000 M€ from ESA plus 400 M€ from MSs) = 1400 M€
  – NGO L1 cost assessed by ESA was 1268 M€
    • Affordable as ESA only!
  – plus 250 M€ international contrib. = 1650 M€ total
    • 250 M€ = 330 M$ → M-Class or Probe @ NASA!

• Use international contributions for cost risk mitigation or performance enhancement!
New NASA Activities

Physics of the Cosmos Program Analysis Group (PhysPAG) Meetings

Fourth Meeting: PhysPAG Workshop 2012

August 14-16, 2012
Holiday Inn Capitol
550 C Street SW
Washington, D.C.

Announcing the fourth PhysPAG meeting, a dedicated workshop in Washington, D.C. The PhysPAG Executive Committee is the Science Organizing Committee for this workshop (see pcos.gsfc.nasa.gov/physpag for more information) and encourages the entire PCOS community to attend. Webcasting will be available for those unable to attend in-person.

Current planned agenda topics include:

- Public presentation/discussion of the reports of PCOS Gravitational Wave and X-ray Studies
- Discussion of PCOS-related ESA missions, including activity on Euclid
- Dark Energy measurements from space (Organizer: Jason Rhodes, jason.d.rhodes AT jpl.nasa.gov)
- Meetings of all four Study Analysis Groups:
  - Inflation Probe SAG (Chair: Shaul Hanany, hanany AT physics.umn.edu)
  - X-ray SAG (Chair: Jay Bookbinder, jbookbinder AT cfa.harvard.edu)
  - Gravitational Wave SAG (Chair: Guido Mueller, mueller AT phys.ufl.edu)
  - Gamma Ray SAG (Chair: Elizabeth Hays, elizabeth.a.hays AT nasa.gov)

Program News

11 May 2012
IPSAG One-Day Workshop, Aug. 15, 2012, Washington, D.C. ➤ Details [PDF]

2 May 2012

2 May 2012
ESA L1 selection announced: JUICE is Europe's next large science mission. High scientific value of NGO and ATHENA recognized and technology activities are planned to continue. ➤ Details

Project News

Chandra News
9 May 2012
Overfired Stellar Holes Shut Down Galactic Star-Making ➤ Details
Interest from China

Prof. Dr. Karsten Danzmann
Max Planck Institute for Gravitational Physics
Callinstr. 38
30167 Hannover

Zusammenarbeit mit China
“Exploratory Round Table Conference (ERTC)”

Thema:
Space Science Research/Satellite Based Scientific Exploration,
Shanghai, Anfang November 2012

Chairman:
Prof. Gerhard Wegner
Max Planck Institute
for Polymer Research
Ackermannweg 10
55128 Mainz / Germany
Phone: +49-6131-379-131
wegner@mpip-mainz.mpg.de

5. April 2012
International plans for space-based detectors

• USA
  – Scenario 1: Junior partner in eLISA (highest priority)
  – Scenario 2: NASA-led mission (SGO)
  – Ongoing technology developments in the US: Telescope, Laser system, Interferometry, Optical Bench technology, GRS, Charge management, torsion pendulum test benches

• China: two options, both in some degree of collaboration with ESA
  – Join eLISA for L2
  – Develop a similar Chinese program if eLISA is selected as L3.
  – Technology: Telescopes, interferometry, GRS and torsion pendulum

• Japan: Decigo-Pathfinder strong candidate for a small mission by Jaxa
Roadmap for LISA

- Preselection of eLISA Science for L2 in 2013
- Call for L2 in 2014
- Industrial Assessment Study 2015
- Fixing of technology gaps not covered by LPF in 2013 – 2015
- Coordination of international partners
- Confirmation Feb 2016 after successful LISA Pathfinder flight in 2015
- Build EQM of complete Payload in 2016 – 2020
- Start industrial implementation in 2020
- Launch in 2028