# Future organisation of LISA science activities

(The LSG and interactions between WGs and WPs)

Jonathan Gair, FPWG meeting, NBI, Copenhagen, August 9th 2023

#### Current LISA timeline



#### LISA Red Book

- \* For adoption, a number of documents are prepared for approval by ESA, including the *Red Book*, which describes the mission being adopted, including science objectives, and the *Science Management Plan*, which describes how science delivery is organised.
- \* Fundamental Physics is one section of the Science Objectives chapter.

## 3.5.1 Use ringdown characteristics observed in MBHB coalescences to test whether the post-merger objects are the MBHs predicted by GR

**SI 5.1** By detecting multiple ringdown "spectral lines" in the post-merger signal of MBHBs LISA can test if merger remnants are indeed Kerr BHs, and place constraints on modifications of GR and on the properties of horizonless massive compact objects.

# $\frac{10^{-1}}{4} + \frac{5}{5} + \frac{6}{6} + \frac{7}{7} + \frac{8}{8} + \frac{9}{9}$ $\log_{10}(M/M_{\odot})$ **LISA Red Book**

3.5.2 Use EMRIs to explore the multipolar structure of MBHs and search for the presence of new light fields

**SI 5.2** LISA aims to observe small objects spiralling into putative MBHs for thousands of cycles, with SNR in excess of 50, thus testing the structure of the spacetime around these objects, probing the presence of dark matter, and potentially measuring charges on the orbiting body associated with new fundamental fields.

#### 3.5.3 Test the presence of beyond-GR emission channels

**SI 5.3** LISA aims to probe the existence of dynamical fields by searching for additional radiation channels and polarisations that would be a smoking gun for non-GR theories.

#### **3.5.4** Test the propagation properties of GW

**SI 5.4** By detecting GWs from golden MBHB coalescences or/and from EMRIs, all with SNR > 200, LISA can probe the propagation of GWs over very large distances by imposing new stringent constraints on dark energy models, modified graviton dispersion relations, and theories of gravity beyond GR.



### Previous organisation



#### Current LSG organisation: roles

#### Work package teams

- Plan: a list of data products (e.g. catalogues, alerts) and discovery papers
- Define: WPs, designed to produce a number of deliverables
- Deliver: project documents or studies; data-analysis specifications, tools, pipelines, code reviews; mock catalogues; websites; ...; but usually not research papers

#### Working groups

- \* **Forum for** free scientific exchange and collaborative research.
- Starting point for defining the LISA science analysis (data products and discovery papers) through a living white paper
- Repositories of talent for WP implementation teams
- WG members organize freely to write short-authorlist research papers
- WG projects —typically exploratory may be incorporated into the WP structure or adopted as deliverable post facto

### Some background to reorganisation

- ESA's perspective:
  - unhappy with the idea of a hardware consortium, as difficult to manage.
  - moving towards a more open data policy. Concerned about appearance that LISA is a closed club, and that data release is delayed, as happened for Planck, Gaia, ....
- NASA's perspective:
  - don't recognise the consortium, but will deal with ESA. Rather than US scientists working within a consortium data analysis/science effort they want to produce their own L2 data and support science exploitation by US scientists.
  - currently have a fully open data policy, but acknowledge need for data verification and that this involves some science analysis.
- Data policy:
  - initial closed data period for data verification (18 months to analyse 6+ months of data) followed by periodic (~yearly) data releases that included catalogues produced by the DDPC/NASA GS. No science on closed data after DR1.

### Proposed data policy

#### **Data Release Policy**





- Periodic Data Releases will be made throughout the mission (~once per year after ERST)
- Scientific validation papers will be published with the data, ala Gaia
- After DR1, science interpretation papers will not be published before the Data Release
- See next chart for ERST and DR1

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### Organisation: LISA Science Team

The LISA Science Team is formed after adoption of the mission by the SPC, and remains in place until the end of the active archival phase. In addition to the ESA Project Scientist who chairs it, and the NASA Project Scientist who co-Chairs it, the LST comprises the following members:

- A representative nominated by the LISA Consortium
- A representative nominated by the LISA Performance and Operations (P&O) Team, who will represent the instrument;
- A representative nominated by the DDPC, who will represent the European data processing teams;
- Up to 11 members covering the instrumentation and main areas relevant for the data processing and scientific objectives of the mission. These members will be selected through a coordinated open call issued by ESA and NASA;
- Up to two "Complementary Scientists", who are experts in fields relevant for complementary science (e.g. Multi-messenger astronomy), selected through an open call issued by ESA.

The LISA Consortium, P&O and DDPC members will be appointed as ex-officio full members of the LST.

A commensurate number of members of the LST will be selected from U.S. institutions.

The LST will set up working groups to provide input/expertise needed for the project.
 This will cover many of the topics of the current LSG work packages.

### Organisation: LISA consortium

The LISA Consortium (LC) is an organisation which represents the knowledge, capabilities and interests of the larger scientific community. The LISA Consortium internal structure and participation mechanisms are not regulated by ESA.

The LISA Consortium provides an organizational forum beyond the working groups and Science Topical Panels set up by the LST. It will set up science interest groups which focus on scientific topics which are either not represented in one of the working groups of the LST or will require integrated data sets well beyond the first data release. Depending on the number, type and size of the LST working groups, the LISA Consortium might also set up larger science interest groups outside the LST WGs to provide pathways for early career scientists to later join the LST WGs. The LISA Consortium will also publicise LISA science to the public.

The LISA Consortium will nominate a representative to serve as an ex-officio member of the LST.

- In new structure the LISA consortium will: form working groups that are not created by the LST; maintain the science WGs to engage with the wider scientific community / provide a pool of resources for the LST working groups; prepare for science on open data; maintain support structures such as the LECS and DEI groups.
- Transition to new structure will be smooth, with an intermediary Council formed shortly before adoption.

#### Organisation: overview



### Organisation: Science Topical Panels

#### ERST



- Early Release Science Time (ERST) makes up the first 18months of the mission
- This time will be used for pipeline validation, L2 production, and the first coherent merging of the L2 products to the single L3 source catalogue
- A set of Science Topical Panels (STP) will be established by the LISA Science Team
  - Chairs and co-Chairs of the STPs will be selected through an open call
  - · Community scientists can then apply to be members of the STPs
    - A board consisting of the Chairs and co-Chairs will approve membership of the STPs
- STPs can publish science interpretation papers using data taken *during* the ERST
  - These papers can be published at any time, but it may make sense to wait until DR1, such that the data can be published with the paper
  - STPs will work with the DDPC and NSGS, but are not limited to their data products
    - · e.g. there could be an STP on space weather
- Data taken after DR1 cannot be used for science interpretation papers until it is published at DR2, etc.

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#### Organisation: launch to DR1



## Organisation: publication Pageolicy

#### 5 **PUBLICATION POLICY**

With each formal data release, a set of pre-defined instrument/science verification papers will be approved by the LST and released with the data. For these, the LST will maintain a list of authors ("LISA Collaboration") who should appear on these papers. This list will include:

- A LISA heritage author list comprising the names of members of the community who have made a significant contribution to the mission. This list does not have an expiration date;
- A LISA member author list comprising scientists and engineers working on the mission at the time of the science operations. This list has a roll-off period of 2 years after the person has left the mission. Following the roll-off period LISA members can be included in the LISA heritage list, if deemed appropriate by the LST.

The above author lists will also be used for the first few high impact discovery papers (e.g., the first massive black hole merger). These papers will only be considered during the ERST, approved by the LST and accompanied with an extraordinary (full) data release.

During the ERST, science interpretation papers will be published by the STPs on their specific science theme. These papers will contain all STP members and the LISA heritage and member list as authors. Papers should acknowledge ESA in the acknowledgement section.

The above policy does not apply to scientific papers published after the ERST.

#### Implications for FPWG/WPs

- Fundamental Physics working group:
  - will continue to exist and play role of community engagement and pool of expertise.
    Most likely it will be a consortium working group because of management implications.
- Work package groups:
  - likely to be at least one LST working group on fundamental physics. Will be a continuation of existing WP groups.
  - role will be to support DDPC and NASA GS activity and ensure that data products are suitable for FP analyses.
  - scope could be broader, depending on vision/requirements of FP science organisation. Could include production of prototype science interpretation pipelines to test DDPC/NASA GS output data products are suitable for FP analysis.
- Paper policy:
  - contributions to date (e.g., WG organisation, WP contributions, white paper writing) will be recognised through the collaboration author list.

### FP work package group

- How the FP work packages evolve will depend how FP science exploitation is organised. Various plausible options
  - (some) constraints on fundamental physics are part of basic catalogues produced by DDPC (not currently planned). [Responsibility: LST, DDPC, NASA GS}
  - FP analyses not part of catalogues, but FP work package group plans to coordinate analyses throughout mission duration, both for DR1 and on open data.
     [Responsibility: Consortium, but expect members seconded to STP for DR1]
  - coordinated FP analyses planned for DR1, within an STP, but no coordination after DR1. [Responsibility: LST, STP chairs]
    - FP work package teams become an LST WG, which naturally evolves into STP.
      Or STP could in principle be formed immediately. Groups may choose to work together informally after DR1, but not guaranteed or expected.
  - no coordination of any FP analyses. [Responsibility: community]
- Best approach will depend on what FP analyses are considered to be key science, what can be done with DR1 data and what data products / codes are needed for FP analyses on LISA data.

- \* We need your input on these questions!
- \* I've prepared a short survey:

#### https://www.menti.com/aly3fjhpho9h

\* Or go to <u>www.menti.com</u> and enter code 2752 7561. Or scan this QR code:



#### Summary

- LISA Science Management plan will establish policies for publications and data releases. Current proposal is that there will be periodic (~yearly) releases of data accompanied by catalogues. First data release (only) will be accompanied by science papers written by science topical panels selected by open call.
- \* Structure of LISA consortium will change after adoption.
- Preparation for science exploitation will primarily be focussed in the DDPC/NASA ground segment and LISA Science Team working groups. FP work package groups will continue in one way or another within this structure.
- Consortium will continue to maintain working groups and other structures to engage with community and provide pool of expertise for LST WGs. FP working group will continue as a consortium-organised entity.
- Past and future in-kind contributions to the consortium will be acknowledged through the consortium author list, used on STP and other key science papers.
- \* Several questions about organisation are still open: **need your input!**

### Extra slides: key questions from poll

- \* What papers should be written on fundamental physics?
  - Is fundamental physics a key science paper that should carry the full author list?
  - What is the threshold for writing such a paper (amount of data, number of events etc.)?
  - Should there be a single paper covering all constraints using DR1 data or multiple papers covering different types of source?
  - Should such constraints (just/also) be within "first SMBH", "first EMRI" papers?

- \* How should FP science exploitation activities be coordinated?
  - FP constraints are part of catalogue data products throughout mission.
  - a single joint FP analysis effort is coordinated by LST STP for DR1 and then by consortium for subsequent DRs (open data).
  - the LST STP does one or more analyses on DR1, then coordination stops. Free-for-all on open data.
- **\*** What organisation is best suited to achieve this?
  - LST forms a FPWG that prepares tools for DR1 analysis (ad hoc after DR1).
  - LST forms one or more FP STPs immediately (ad hoc after DR1).
  - consortium forms a FP WP group that prepares pipelines to analyse open data.
    Members likely to be coopted to relevant STP(s).
  - no coordination now or after DR1. Open call for STP prior to launch.

#### \* What data products do you think you will need to do your FP analyses?

- a catalogue constructed from a global fit including GR deviations.
- a catalogue constructed using GR waveforms.
- TDI data streams only, with no sources extracted.
- raw phase measurements.
- \* What codes for manipulating the data should the DDPC make available?
  - full global fit with bespoke waveform models.
  - code to generate waveforms that were used during fitting, and tools to add/ subtract sources from the data.
  - only clear documentation describing what was done to generate the catalogues.