Call for White Papers
for the Voyage 2050 long-term plan
in the ESA Science Programme

1 INTRODUCTION

The Science Programme of the European Space Agency (ESA) relies on long-term planning of its scientific priorities. The first long-term plan, Horizon 2000, was the result of an exercise started in 1983, and it was followed by an extension, Horizon 2000 Plus, that resulted in the initiation of the Gaia and BepiColombo missions. The successive planning exercise, Cosmic Vision[1], was started in 2004, and is the current basis against which the content of the Science Programme is set.

Cosmic Vision is the result of a bottom-up process that began with a consultation of the broad scientific community. The plan, which comprises a variety of missions and extends up to 2035, defines the wide-ranging and ambitious scientific questions to be addressed by missions in the ESA Science Programme.

The next planning cycle of the ESA Science Programme, Voyage 2050, is now underway. Through the present Call for White Papers the Director of Science invites the broad scientific community to submit their ideas for science themes that should be addressed by the Voyage 2050 planning cycle, covering the period 2035 to 2050.

2 STRUCTURE OF THE ESA SCIENCE PROGRAMME

The Science Programme implements a regular cadence of missions of various sizes whose goal is to address the science topics defined in the long-term plan. Missions are proposed by the science community in response to open calls for missions and follow a thorough competitive, peer-reviewed process before being proposed to the Science Programme Committee (SPC) for selection first and later adoption (the SPC decision to proceed to the implementation phase).

The current Cosmic Vision planning cycle extends to 2035 and includes four types of missions:

- Large (L) missions are flagship, ESA-led missions, with a planning cost for ESA of

[1] Described in ESA BR-247, https://www.esa.int/esapub/br/br247/br247.pdf

1000-1200 M€ (around 2 annual budgets). They can include international contributions. The cadence of L missions is typically one every 7-8 years. The L missions in the Cosmic Vision plan are: JUICE (L1), Athena (L2), and LISA (L3).

- Medium (M) missions are flexible missions, either ESA-led or partner-led, with a planning cost for ESA of 550-600 M€ (around 1 annual budget). The cadence of M missions is typically one every 4-5 years. The M missions in the Cosmic Vision plan are: Solar Orbiter (M1), Euclid (M2), PLATO (M3), and ARIEL (M4), while for the M5 slot three candidates (EnVision, SPICA, and Theseus) are under study (with a selection planned in 2021).

- Smaller missions include a variety of categories, with an ESA planning cost of 50 to 150 M€. CHEOPS and SMILE are examples of this.

- Missions of Opportunity[2] are modest-sized contributions to partner-led missions, with an ESA cost limited to ca. 50 M€.

ESA Science Missions are in all cases implemented as partnerships with the Member States, that supply most or all of the scientific payloads and/or elements of the scientific ground system. Mission elements funded by Member States are an essential contribution for the success of the missions, and their financial value is not reflected in the figures above.

Information on the portfolio of missions in the ESA Science Programme can be accessed at: http://sci.esa.int/home/51459-missions.

3 THE VOYAGE 2050 PROCESS

The Director of Science is consulting the broad scientific community to establish the next long-term plan, Voyage 2050, for the ESA Science Programme. This follows on the previous long-term plans (including the extant Cosmic Vision plan, described above), and will be the basis upon which space science missions in ESA are defined in the time frame from approximately 2035 up to 2050.

3.1 *Structure of the future Science Programme*

The Science Programme of ESA in the decades until 2050 will be comprised of a mixture of mission types, with three Large (L) missions and six to seven Medium (M) missions being envisaged, as well as a number of smaller programme elements (including Missions of Opportunity). This is similar to the structure of the current Science Programme described in Section 2.

In keeping with the bottom-up, peer-reviewed nature of the Science Programme, the definition of the next plan relies on open community input and on broad peer review. The community input will be gathered through the present Call for White Papers, while the peer review of this input will take place through a two-tiered committee structure, with a Senior

[2] An overview of Missions of Opportunity can be found here: http://sci.esa.int/cosmic-vision/59977-missions-of-opportunity/

Committee of 13 European scientists (see Appendix 1) supported by a number of Topical Teams. A Call for Membership of the Topical Teams will be issued in parallel to this Call for White Papers.

3.2 *Senior Committee*

The Director of Science has appointed the Senior Committee to guide the Voyage 2050 process. This Committee, composed of scientists working in institutions in ESA Member States, is tasked to:

1. Recommend to the Director of Science the three science themes of the three L missions that will be part of the plan.

2. Identify a number of high-impact science themes that could be implemented through an M mission during the plan's time span. The actual M missions will be decided through open calls for missions issued in due time to retain flexibility in the Science Programme. However, the early identification of themes of interest will help the Agency in, e.g., developing key technologies.

3. Identify a number of science themes for which the technology is not sufficiently mature to allow their implementation in the time frame up to 2050, but that might become fruitful areas of investigation in the future should the technology become sufficiently mature. These themes will be used to guide the Agency's investment in longer-term technology development.

Following receipt of the White Papers submitted in response to this Call the Senior Committee and the Topical Teams will work through the second half of 2019 and the first half of 2020, issuing their recommendations to the Agency in mid 2020. The Agency intends to publish the final report describing the Voyage 2050 plan toward the end of 2020.

3.3 *Topical Teams*

The Senior Committee will be supported in its work by a number of Topical Teams. Each Topical Team will be composed of between 10 and 20 scientists with the task of analysing the White Papers. The Topical Teams will provide the Senior Committee with an evaluation of the strengths and weaknesses of each White Paper, together with a broad assessment of the "state of the field" (current and projected) in their scientific domain, and an assessment of whether the received White Papers cover satisfactorily the range of topics that might be usefully addressed with space missions in the time frame until 2050.

3.4 *Public consultation*

In parallel, the Agency is consulting the broad European public, inviting the public to share their views on the questions that Voyage 2050 should address. The details of the public consultation can be found at http://sci.esa.int/discovering-our-universe.

4 WHITE PAPERS

By means of the present Call for White Papers, the Agency is soliciting ideas from the scientific community for the science themes that should be covered during the Voyage 2050 planning cycle.

White Papers are not proposals for specific missions; they should rather argue why a specific scientific theme should have priority in the Voyage 2050 planning cycle. At the same time, and to ensure realism in the resulting Programme, applicants should briefly illustrate possible mission profiles.

4.1 *Eligibility*

Any scientist or science team can submit a White Paper, with no limitation in terms of residence or nationality. All White Papers must be submitted in English. White Paper lead scientists (i.e., those who are designated as the Contact Scientist) cannot be members of the Topical Teams described above.

4.2 *White Paper structure*

White Papers are limited to 20 A4 pages (plus title page and bibliography, see below), with minimum font size 11 points. The structure and page limitation of the White Papers is:

- A cover page (that should include the applicant's contact information and title of the submission);
- A back cover page listing the members of the proposing team;
- A maximum of 20 pages for the proposal, including tables and figures;
- A maximum of 6 pages for the bibliography.

While there are no constraints on the structure of the content, White Paper authors should ensure that the following questions are properly addressed:

1. Describe clearly the proposed science question(s) that you propose to be addressed by the future Science Programme of the Agency. The proposal should place the proposed science question(s) in the broad context of contemporary science, and in the context of the foreseen advancement of scientific knowledge at large and of the specific field in particular.

2. Briefly describe how a space mission would address these scientific questions. Proposers are welcome to discuss whether the proposed science is effectively addressed through an L mission, an M mission, or with smaller mission profiles. Should proposers feel that the science goals require an L mission, they are encouraged to discuss if and what fraction of the science might be addressed with a smaller mission profile.

3. Proposers are encouraged to explain how the science mission that would address the proposed science goal would fit in a worldwide context of space (and, if applicable, ground-based) science.

4. Proposers should explicitly address any technology challenges that they believe would be enabling for addressing the science questions discussed in the White Paper.

4.3 *Authorship*

White Papers must clearly indicate a single Contact Scientist, and may list a maximum of 30 scientists as members of the Core Proposing Team. As described below, authorship of a White Paper does not confer any priority toward possible submission of future mission proposals to the Science Programme.

The Contact Scientist will be the only point of contact between the Agency and the proposing team.

Applicants are advised to read the *Call for Membership in the Topical Teams* for further information about the Voyage 2050 process. Additional information about Voyage 2050 and the Calls can be found online at:

https://cosmos.esa.int/voyage-2050

4.4 *Intellectual property and confidentiality*

Submission of a White Paper in response to the present Call does not confer the applicant(s) with any right to intellectual property for the ideas contained in the White Paper. The Agency will publish the White Papers in electronic form shortly after the submission deadline, and the material will therefore be public. For this reason, none of the material contained in the submission should be confidential in nature.

Any future space mission resulting from the present process will be selected through a competitive process. The submission of a White Paper does not grant the submitting team any priority in future competitive processes.

4.5 *Submitting White Papers*

White Papers will be accepted exclusively in PDF format, with a maximum file size of 50 MB, using the interface available at:

https://www.cosmos.esa.int/web/voyage-2050/call-for-white-papers

The deadline for submission of White Papers in response to the present Call is given in Section 6. Late submissions will not be considered. The submission deadline will be implemented strictly and proposers are invited to submit their proposals well in advance of the deadline. White Papers that exceed the page limit or that do not respect the structure described above in Section 4.2 will not be considered.

5 OPEN WORKSHOP

The Agency intends to invite a number of the Contact Scientists who have submitted a White Paper to present their ideas at an open workshop planned to be held in October 2019. Further details about the workshop will be announced separately.

6 DEADLINES AND SCHEDULE

Activity	Date
Call for White Papers issued	4 March 2019
Deadline for receipt of White Papers	5 August 2019, 12:00 (noon) CEST
Workshop to present White Papers	October 2019

7 FURTHER INFORMATION AND CONTACT POINTS

Requests for further information should be addressed to:

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Appendix 1: Composition of the Senior Committee

Name	**Affiliation**
Linda Tacconi (Chair)	Max Planck Institute for Extraterrestrial Physics, Garching, Germany
Chris Arridge (Co-Chair)	Lancaster University, United Kingdom
Alessandra Buonanno	Max Planck Institute for Gravitational Physics, Potsdam, Germany
Mike Cruise	Retired, United Kingdom
Olivier Grasset	University of Nantes, France
Amina Helmi	University of Groningen, Netherlands
Luciano Iess	Sapienza University of Rome, Italy
Eiichiro Komatsu	Max Planck Institute for Astrophysics, Garching, Germany
Jérémy Leconte	CNRS/Bordeaux University, France
Jorrit Leenaarts	Stockholm University, Sweden
Jesús Martín-Pintado	Spanish Astrobiology Center (CAB), Madrid, Spain
Rumi Nakamura	Space Research Institute, Austrian Academy of Sciences, Austria
Darach Watson	University of Copenhagen, Denmark