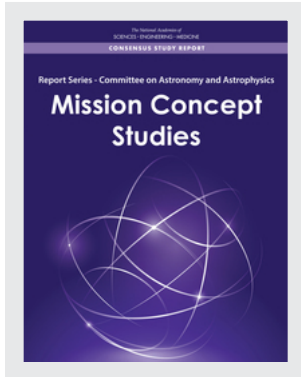


This PDF is available at <http://nap.edu/25212>

SHARE



Report Series: Committee on Astronomy and Astrophysics: Mission Concept Studies

DETAILS

11 pages | 8.5 x 11 | PAPERBACK

ISBN 978-0-309-48238-7 | DOI 10.17226/25212

CONTRIBUTORS

Committee on Astronomy and Astrophysics; Space Studies Board; Board on Physics and Astronomy; Division on Engineering and Physical Sciences; National Academies of Sciences, Engineering, and Medicine

GET THIS BOOK

FIND RELATED TITLES

Visit the National Academies Press at NAP.edu and login or register to get:

- Access to free PDF downloads of thousands of scientific reports
- 10% off the price of print titles
- Email or social media notifications of new titles related to your interests
- Special offers and discounts



Distribution, posting, or copying of this PDF is strictly prohibited without written permission of the National Academies Press. (Request Permission) Unless otherwise indicated, all materials in this PDF are copyrighted by the National Academy of Sciences.

Copyright © National Academy of Sciences. All rights reserved.

Report Series - Committee on Astronomy and Astrophysics

Mission Concept Studies

Committee on Astronomy and Astrophysics

Space Studies Board

Board on Physics and Astronomy

Division on Engineering and Physical Sciences

A Consensus Study Report of
The National Academies of
SCIENCES • ENGINEERING • MEDICINE

THE NATIONAL ACADEMIES PRESS

Washington, DC

www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, NW Washington, DC 20001

This activity was supported by Contract No. NNH11CD57B with the National Aeronautics and Space Administration, Grant No. AST-1533814 with the National Science Foundation, and Contract No. DE-SC0014211 with the Department of Energy. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of any organization or agency that provided support for the project.

International Standard Book Number-13: 978-0-309-48238-7

International Standard Book Number-10: 0-309-48238-0

Digital Object Identifier: <https://doi.org/10.17226/25212>

Copies of this report are available free of charge from:

Space Studies Board
National Academies of Sciences, Engineering, and Medicine
500 Fifth Street, NW
Washington, DC 20001

Copyright 2018 by the National Academy of Sciences. All rights reserved.

Printed in the United States of America

Suggested Citation: National Academies of Sciences, Engineering, and Medicine. 2018. *Report Series: Committee on Astronomy and Astrophysics—Mission Concept Studies*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/25212>.

The National Academies of **SCIENCES • ENGINEERING • MEDICINE**

The **National Academy of Sciences** was established in 1863 by an Act of Congress, signed by President Lincoln, as a private, nongovernmental institution to advise the nation on issues related to science and technology. Members are elected by their peers for outstanding contributions to research. Dr. Marcia McNutt is president.

The **National Academy of Engineering** was established in 1964 under the charter of the National Academy of Sciences to bring the practices of engineering to advising the nation. Members are elected by their peers for extraordinary contributions to engineering. Dr. C. D. Mote, Jr., is president.

The **National Academy of Medicine** (formerly the Institute of Medicine) was established in 1970 under the charter of the National Academy of Sciences to advise the nation on medical and health issues. Members are elected by their peers for distinguished contributions to medicine and health. Dr. Victor J. Dzau is president.

The three Academies work together as the **National Academies of Sciences, Engineering, and Medicine** to provide independent, objective analysis and advice to the nation and conduct other activities to solve complex problems and inform public policy decisions. The National Academies also encourage education and research, recognize outstanding contributions to knowledge, and increase public understanding in matters of science, engineering, and medicine.

Learn more about the National Academies of Sciences, Engineering, and Medicine at www.nationalacademies.org.

The National Academies of
SCIENCES • ENGINEERING • MEDICINE

Consensus Study Reports published by the National Academies of Sciences, Engineering, and Medicine document the evidence-based consensus on the study's statement of task by an authoring committee of experts. Reports typically include findings, conclusions, and recommendations based on information gathered by the committee and the committee's deliberations. Each report has been subjected to a rigorous and independent peer-review process and it represents the position of the National Academies on the statement of task.

Proceedings published by the National Academies of Sciences, Engineering, and Medicine chronicle the presentations and discussions at a workshop, symposium, or other event convened by the National Academies. The statements and opinions contained in proceedings are those of the participants and are not endorsed by other participants, the planning committee, or the National Academies.

For information about other products and activities of the National Academies, please visit www.nationalacademies.org/about/whatwedo.

COMMITTEE ON ASTRONOMY AND ASTROPHYSICS

MARCIA J. RIEKE, NAS,¹ University of Arizona, *Co-Chair*
STEVEN M. RITZ, University of California, Santa Cruz, *Co-Chair*
JEREMIAH K. DARLING, University of Colorado, Boulder
MEGAN DONAHUE, Michigan State University
THOMAS GREENE, NASA Ames Research Center
LEE W. HARTMANN, University of Michigan
VASSILIKI KALOGERA, NAS, Northwestern University
BRUCE MACINTOSH, Stanford University
CHRISTOPHER F. MCKEE, NAS, University of California, Berkeley
ANGELA V. OLINTO, University of Chicago
MARK M. PHILLIPS, Carnegie Institution for Science
JAMES M. STONE, Princeton University
ALEXEY VIKHLININ, Harvard-Smithsonian Center for Astrophysics
ERIC M. WILCOTS, University of Wisconsin
A. THOMAS YOUNG, NAE,² Lockheed Martin, retired

Staff: DAVID LANG, Senior Program Officer, Board on Physics and Astronomy, *Study Director*; MIA BROWN, Research Associate, Space Studies Board; DIONNA WISE, Senior Program Coordinator, Space Studies Board; RICHARD ROWBERG, Interim Acting Director, Space Studies Board and Aeronautics and Space Engineering Board; JAMES C. LANCASTER, Director, Board on Physics and Astronomy

SPACE STUDIES BOARD

FIONA HARRISON, NAS, California Institute of Technology, *Chair*
ROBERT D. BRAUN, NAE,³ University of Colorado, Boulder, *Vice Chair*
DAVID N. SPERGEL, NAS, Princeton University and Center for Computational Astrophysics at the Simons Foundation, *Vice Chair*
JAMES G. ANDERSON, NAS, Harvard University
JEFF M. BINGHAM, Consultant
JAY C. BUCKEY, Geisel School of Medicine at Dartmouth College
MARY LYNNE DITTMAR, Dittmar Associates
JOSEPH FULLER, JR., Futron Corporation
THOMAS R. GAVIN, California Institute of Technology
SARAH GIBSON, National Center for Atmospheric Research
WESLEY T. HUNTRESS, Carnegie Institution of Washington
ANTHONY C. JANETOS, Boston University
CHRYSSA KOUVELIOTOU, NAS, George Washington University
DENNIS P. LETTENMAIER, NAE, University of California, Los Angeles
ROSALY M. LOPES, Jet Propulsion Laboratory
DAVID J. MCCOMAS, Princeton University
LARRY PAXTON, Johns Hopkins University, Applied Physics Laboratory
SAUL PERLMUTTER, NAS, Lawrence Berkeley National Laboratory
ELIOT QUATAERT, University of California, Berkeley
BARBARA SHERWOOD LOLLAR, University of Toronto
HARLAN E. SPENCE, University of New Hampshire
MARK H. THIEMENS, NAS, University of California, San Diego
MEENAKSHI WADHWA, Arizona State University

¹ Member, National Academy of Sciences.

² Member, National Academy of Engineering.

³ Member, National Academy of Engineering.

BOARD ON PHYSICS AND ASTRONOMY

BARBARA V. JACAK, NAS, Lawrence Berkeley National Laboratory, *Chair*
ABRAHAM LOEB, Harvard University, *Vice Chair*
LOUIS F. DIMAURO, The Ohio State University
FRANCIS J. DiSALVO, NAS, Cornell University
TODD DITMIRE, University of Texas, Austin
NATHANIEL J. FISCH, Princeton University
DANIEL FISHER, NAS, Stanford University
WENDY FREEDMAN, NAS, University of Chicago
TIMOTHY M. HECKMAN, NAS, Johns Hopkins University
WENDELL T. HILL III, University of Maryland
ALAN J. HURD, Los Alamos National Laboratory
BARBARA A. JONES, IBM Almaden Research Center
ANDREW J. LANKFORD, University of California at Irvine
NERGIS MAVALVALA, NAS, Massachusetts Institute of Technology
LYMAN A. PAGE, JR., NAS, Princeton University
STEVEN M. RITZ, University of California Santa Cruz

ACKNOWLEDGMENT OF REVIEWERS

This Consensus Study Report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making each published report as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following individuals for their review of this report:

CHARLES ALCOCK, NAS, Harvard-Smithsonian Center for Astrophysics,
JON ARENBERG, Northrop Grumman Aerospace Systems,
ROGER BLANDFORD, NAS, Stanford University,
GLENN LIGHTSEY, Georgia Institute of Technology,
AMY MLINAR, Planetary Science Institute,
JOSEPH SILK, NAS, Université Pierre et Marie Curie, Paris, France, and
GRANT STOKES, NAE, MIT Lincoln Laboratory.

Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations of this report nor did they see the final draft before its release. The review of this report was overseen by Charles F. Kennel, NAS, University of California, San Diego. He was responsible for making certain that an independent examination of this report was carried out in accordance with the standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the authoring committee and the National Academies.

Introduction

The Committee on Astronomy and Astrophysics (CAA) is tasked with monitoring the progress of the recommended priorities of the astronomy and astrophysics decadal survey of the National Academies of Sciences, Engineering, and Medicine and providing “an independent, authoritative forum for identifying and discussing issues in astronomy and astrophysics between the research community, the federal government, and the interested public.” The CAA therefore routinely discusses preparations for the next astronomy and astrophysics decadal survey, Astro2020. One of the important pre-survey activities is the definition of mission concepts in a manner that supports the survey process. This short report is the result of a request from NASA. The statement of task is as follows:

In a brief report, the Committee on Astronomy and Astrophysics (CAA) will review NASA’s plans for delivering mission concept studies (large and medium) to the Decadal Survey Committee. The CAA will assess the appropriateness of NASA’s plans and, if needed, provide findings for the purpose of improving the value of NASA’s preparations to the Decadal Survey Committee. NASA will provide information to the CAA on the expectations for each mission concept study, including the content of their final reports, a timeline for their reports’ delivery, and the plans for independent reviews to be conducted by NASA. NASA will also provide to the CAA a proposed list of materials that NASA plans to deliver to the Decadal Survey Committee.

Discussion

The full process of preparing for Astro2020 that has been undertaken by NASA is described in the material available at <https://science.nasa.gov/astrophysics/2020-decadal-survey-planning>. The activities are described here briefly.

In 2013, NASA released a document entitled “Enduring Quests Daring Visions,” which is the result of discussions laying out NASA Astrophysics missions and activities for the next 30 years. Three of the missions described in this study, Far-IR Surveyor, LUVOIR Surveyor, and X-ray Surveyor, have become Origins Space Telescope (OST), Large Ultraviolet Optical Infrared Surveyor (LUVOIR), and Lynx X-ray Surveyor (Lynx), respectively. A fourth large mission, Habitable Exoplanet Imaging Mission (HabEx), has also been defined. These four large mission concepts are being developed by study teams funded by NASA Astrophysics to ensure that all four are well prepared for consideration by Astro2020. Each of these missions has encouraged community participation, and the URLs listed in the Appendix document the meetings, discussions, and work of the study groups. Final reports from each study are to be delivered in summer of 2019 for use by Astro2020 and will include independent cost evaluations but not full-blown cost and technical evaluation (CATE) exercises prior to submission to Astro2020.

In addition to funding four large mission concept studies, NASA Astrophysics also solicited proposals for probe-class studies in August 2016. Ten concepts were selected for funding, with reports due in summer of 2019 for use by Astro2020. These studies are smaller in scope than the four large mission studies and are notionally cost-capped at \$1 billion. They could also be called “medium-class” but are larger than Explorers. These distinctions are based on life-cycle costs. They include limited independent cost assessments but not CATEs. It is anticipated

that Astro2020 may receive inputs from probe-class mission studies that were not included in the group of 10 funded by NASA.

The CAA met in conjunction with Space Studies Week 2018 in Washington, D.C., on March 27-29, 2018, and at this meeting, the CAA discussed whether the information that is likely to be delivered to Astro2020 would be adequate. In advance of that meeting, the CAA discussed the task with NASA in a teleconference on February 26, 2018. NASA had routinely presented the planning and implementation of the mission concept development efforts to the CAA at prior meetings. Further details were made available to the CAA prior to the February teleconference. The CAA also examined the request for information (RFI) to projects by the 2010 decadal survey CATE process and consulted with survey committee and panel members at the March CAA meeting about the relative importance of these items for the decadal survey. Table 1 summarizes the experience that CAA members bring from serving on previous decadal surveys, which informed the discussion. In addition, during the March CAA meeting, the CAA had a teleconference with Steven Battel, Battel Engineering, Inc., who served on the Astro2010 survey committee and played a key role in devising the CATE process.

TABLE 1 Decadal Survey Service of Members of the Committee on Astronomy and Astrophysics

CAA Member	Decadal Survey Service
Marcia Rieke	Astro2010 Program Prioritization Vice Chair
Steven Ritz	Astro2010 Committee Member
A. Thomas Young	Astro2010 Committee Member, PPP Oversight Subcommittee
Lee Hartmann	Astro2010 Chair of Planetary Systems and Star Formation Panel
Eric Wilcots	Astro2010 Member of Galaxies Across Cosmic Time Panel
Megan Donahue	Astro2010 Member of Electromagnetic Observations from Space Panel
Thomas Greene	Astro2010 Member of Electromagnetic Observations from Space Panel
Bruce Macintosh	Astro2010 Member of Optical and IR Astronomy from Ground Panel
Angela Olinto	Astro2010 Member of Particle Astrophysics and Gravitation Panel
Christopher McKee	2001 Decadal Survey Co-Chair

Findings

The CAA commends NASA for its sustained and well-considered efforts to prepare the needed project information for the next decadal survey. As described above, the process was open and had wide community participation. Based on the information presented and the trajectory of the activities, the outcomes of these activities should provide a sound basis for the Astro2020's evaluation.

Findings that could help improve the value to Astro2020:

1. It would be helpful if each of the concept reports clearly shows the key mission requirements, which is derived from the science drivers and how they affected the design. This could include, for example, a science traceability matrix.

2. Astro2010 did not request information on possible descopes. The lack of this information hindered discussions. For Astro2020, mission concept studies could include possible descope and upgrade options and the science impact of such changes. Estimates of cost changes could be included. Implicit in this suggestion is the related suggestion that mission capabilities be prioritized.
3. Enumeration and evaluation of the risks are essential inputs to the decadal survey. These design and costing exercises present opportunities for mission concept teams to learn how to communicate risks effectively to the decadal survey.
4. NASA's process of reviewing mission concept study reports before submission to the decadal survey will avoid problems associated with study reports providing dissimilar levels of detail and would help ensure a clear basis of comparison by the decadal survey. The prescribed format for the probe final reports could be adapted for the large missions as well.
5. The probe and large mission studies are being done somewhat differently, with the large missions having more time, resources, and possibly more opportunities to optimize the design. Based on experience in the previous decadal survey, it will be important to check that the probes have optimized the design and the presentation of the information, to the extent practical, given available resources.
6. Mission concept teams that did not participate in this preparatory process may still submit their concepts to the decadal survey. Substantial changes from the open submission policies followed by Astro2010 are not anticipated.
7. Probes have clear guidance about cost caps. Large mission studies are less constrained and have been instructed by NASA to give a range of performance and cost points. This guidance to the large missions about affordability and further guidance about NASA's anticipated budgets will help align the results to the needs of the survey, which will also be given information from NASA about its anticipated budgets.

Appendix

Concept Study URLs Documenting Community Participation

HabX—Habitable Exoplanet Imaging Mission

<https://www.jpl.nasa.gov/habex/>
<https://www.jpl.nasa.gov/habex/news-events/>
<https://www.jpl.nasa.gov/habex/documents/>

LUVOIR—Large Ultraviolet Optical Infrared Surveyor

<https://asd.gsfc.nasa.gov/luvoir/>
<https://asd.gsfc.nasa.gov/luvoir/events/>
<https://asd.gsfc.nasa.gov/luvoir/resources/>

Lynx—Lynx X-ray Surveyor

<https://wwwastro.msfc.nasa.gov/lynx/>
<https://wwwastro.msfc.nasa.gov/lynx/docs/newsletters/>
<https://wwwastro.msfc.nasa.gov/lynx/docs/meetings/>

OST—Origins Space Telescope

<https://asd.gsfc.nasa.gov/firs/>
<https://asd.gsfc.nasa.gov/firs/events/>
<https://asd.gsfc.nasa.gov/firs/docs/>