National Aeronautics and Space Administration

GOMAP Update

NASA Astrophysics Great Observatory Maturation Program (GOMAP)
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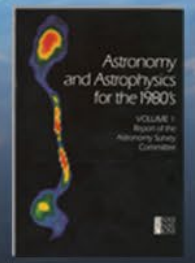
October 20, 2023

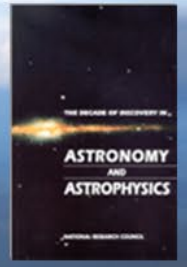
Astrophysics

Decadal Survey Missions

1972
Decadal Survey
Hubble



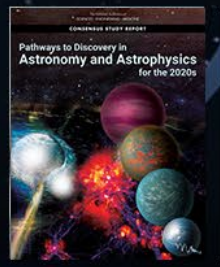
1982
Decadal Survey
Chandra



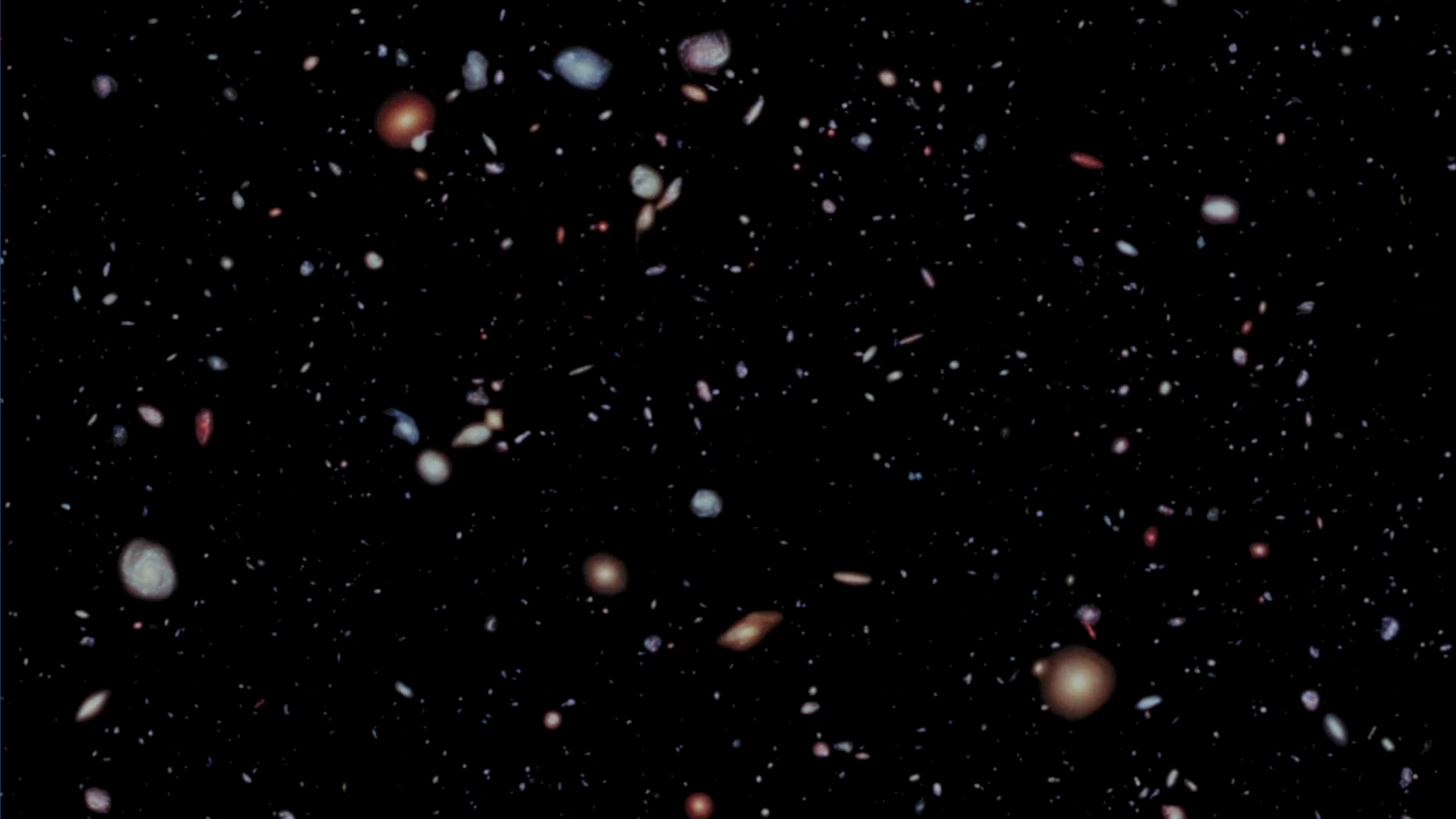
1991
Decadal Survey
Spitzer

2001
Decadal Survey
Webb

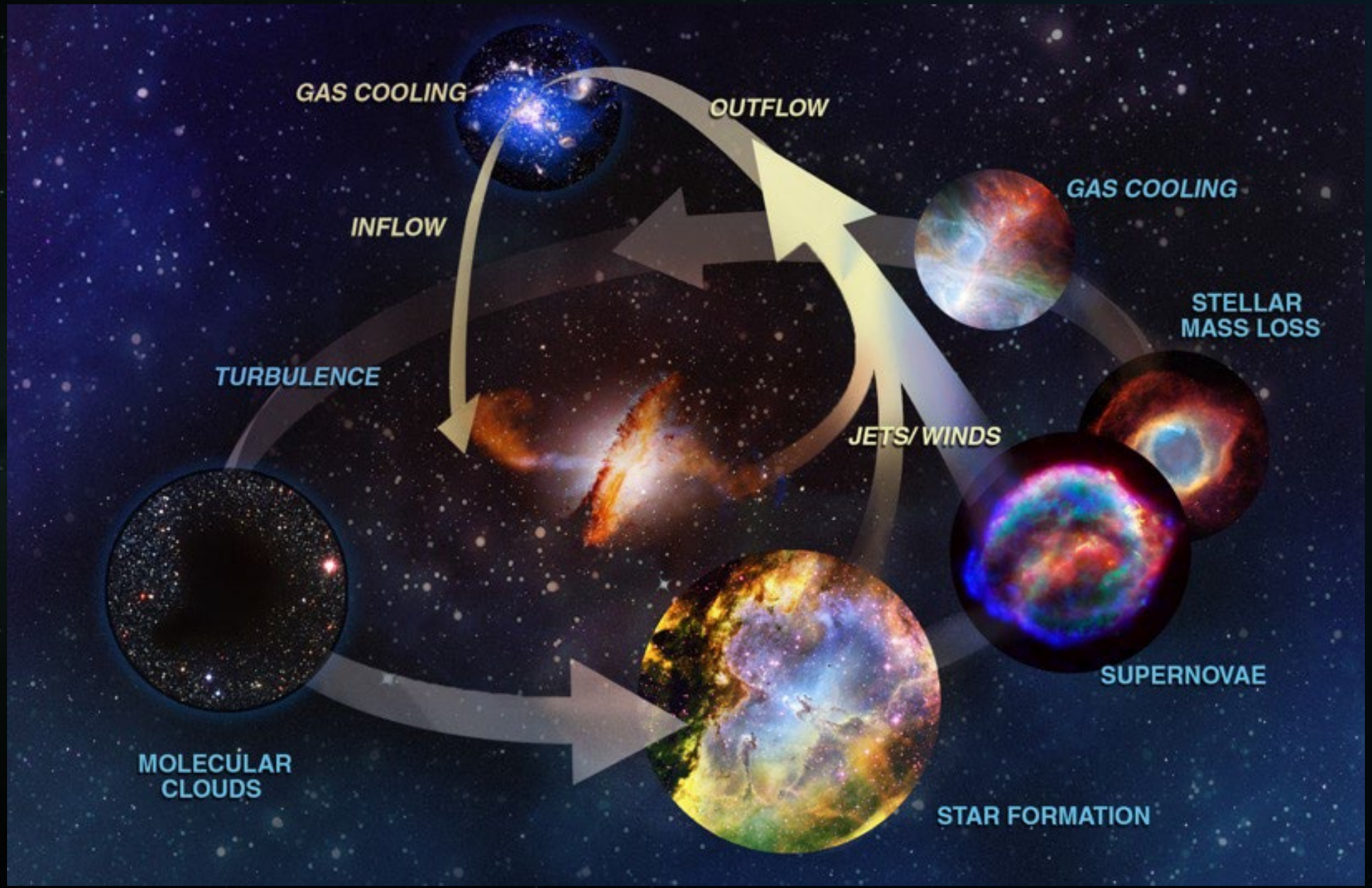
2010
Decadal Survey
Roman



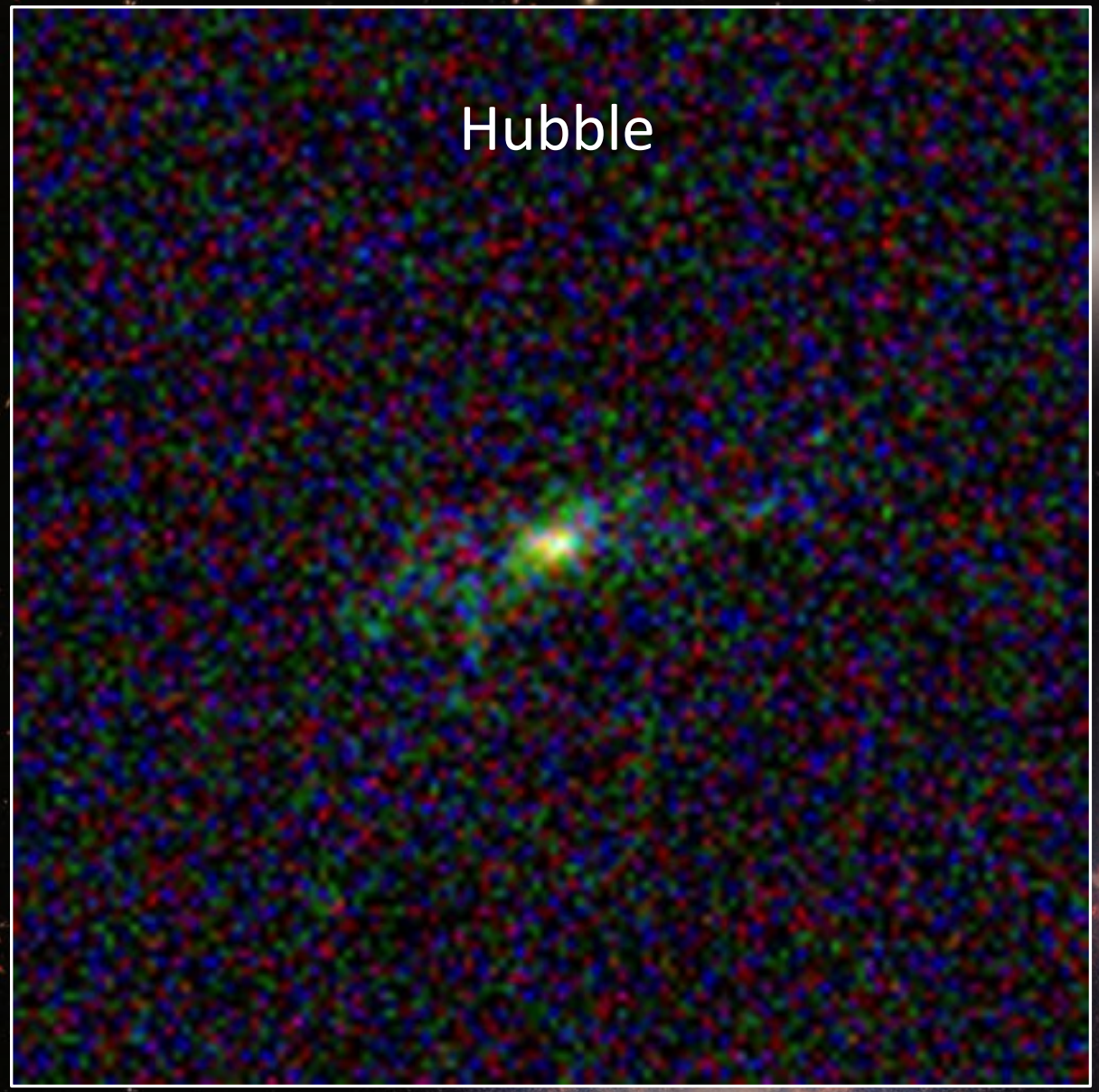
2021
Decadal Survey

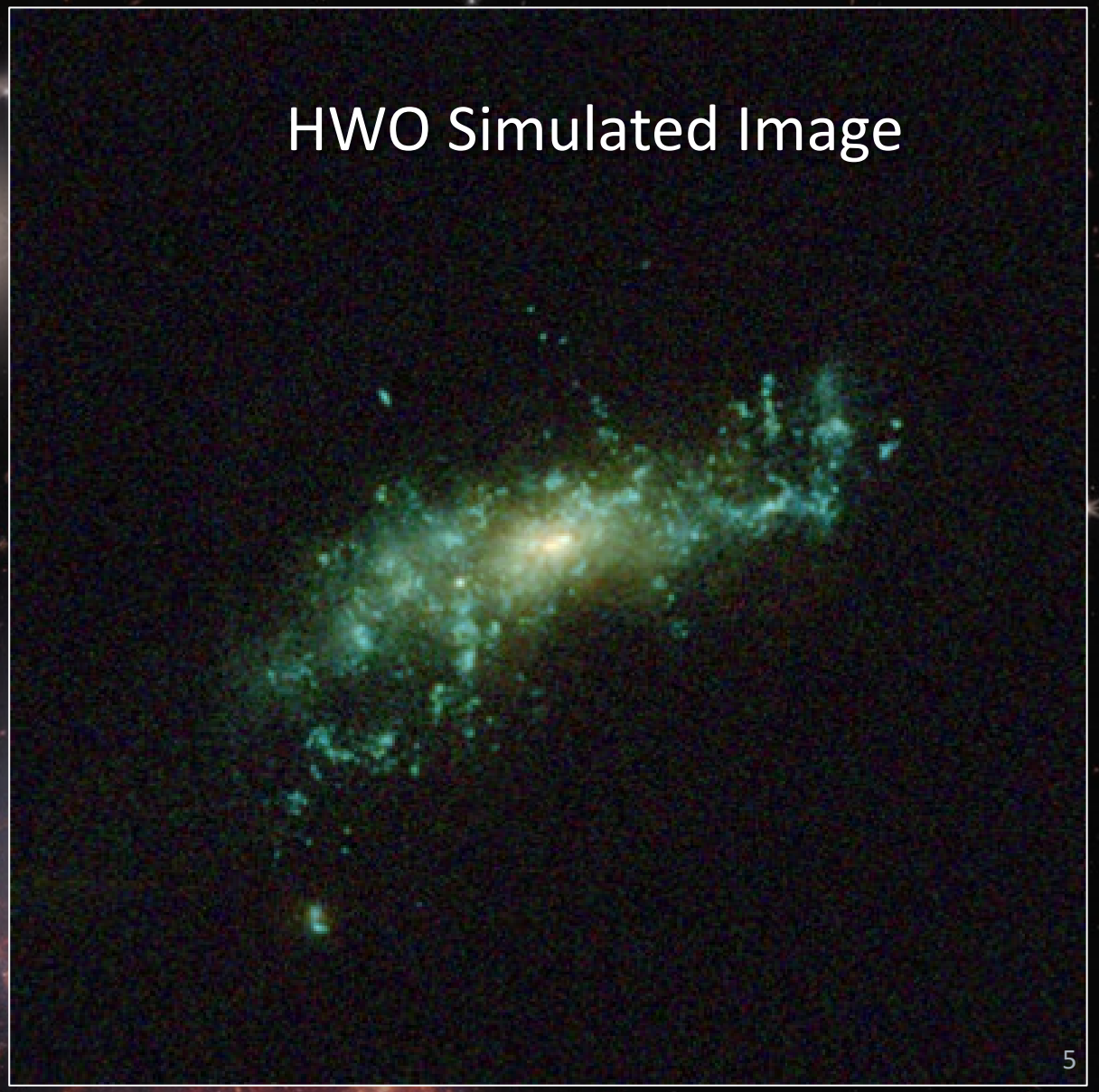


Studying the Lifecycles of Galaxies

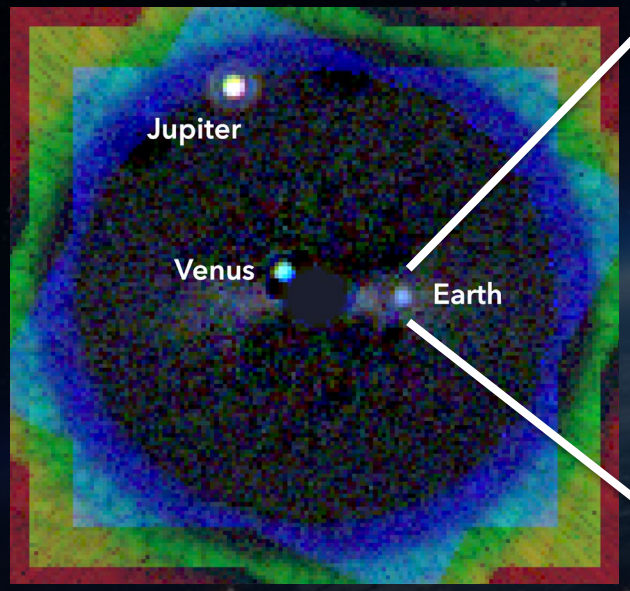


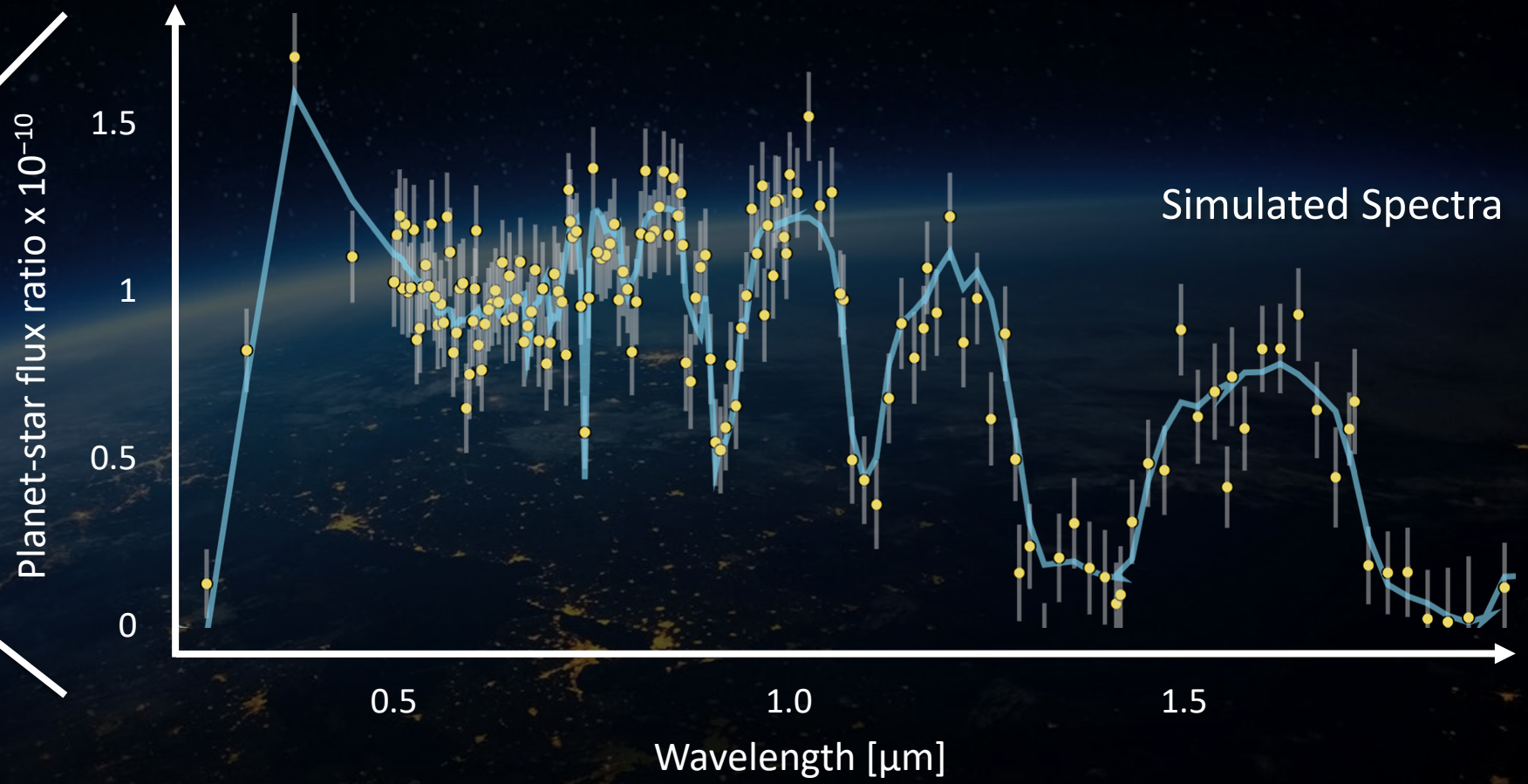
Probing the Properties of Dark Matter with Dwarf Galaxies





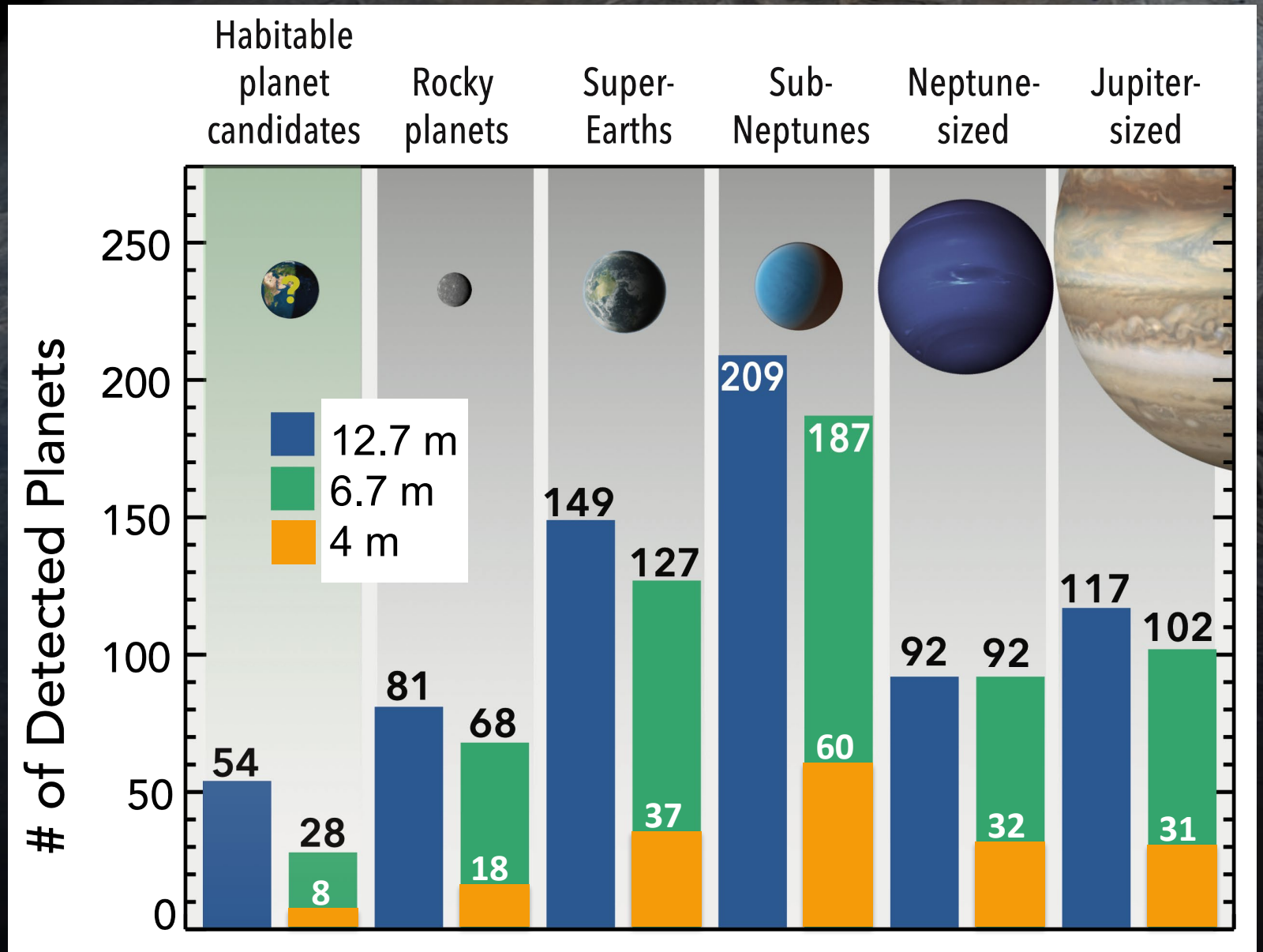
Searching for Life Outside the Solar System





Analyze light directly reflected by the planet, with little or no starlight mixed in

Exploring the Diverse Range of Exoplanets



HWO can reveal what these exotic worlds are really like

Why GOMAP? Decades of research-based consensus on megaprojects

Independent Research Papers

Challenges and Potential Solutions to Develop and Fund NASA Flagship Missions

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Abstract—Large, strategic "Flagship" missions have unique characteristics that lead to challenging developmental difficulties for the National Aeronautics and Space Administration (NASA). Missions such as the Hubble Space Telescope (HST), James Webb Space Telescope (JWST), and the Mars Science Laboratory (MSL) had technical and programmatic challenges that led to significant schedule delays and subsequent cost growth. Although NASA has instituted policies that have reduced cost growth for more "typical" NASA science missions, NASA Flagship missions remain a distinct challenge due to their requirement to provide unprecedented science or tackle bold exploration goals, typically while concurrently developing new technologies. The unique challenges presented by Flagship missions make it extremely difficult to fully predict cost and schedule given that the technical and programmatic advances needed to meet performance requirements are unprecedented. This paper addresses why Flagship missions are unique and proposes a new programmatic approach to develop and fund Flagship missions.

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1. DEFINITION OF FLAGSHIP MISSIONS

According to Miriam-Webster's Dictionary, a Flagship is: 1) the ship that carries the commander of a fleet or subdivision of a fleet and flies the commander's flag, or 2) the finest, largest, or most important one of a group of things. [1] In many ways, National Aeronautics and Space Administration (NASA) Flagship missions incorporate both of these definitions as they are the most visible because of their potential for scientific discovery and expense and are also the finest, largest, and most important of NASA's science missions. NASA Flagship missions are unprecedented in the science that they enable as they provide exquisite measurements that cannot be done otherwise and typically require new technology or advanced engineering developments to acquire the measurements.

Figure 1 shows typical examples of NASA Flagship missions such as Viking, Galileo, the Hubble Space Telescope (HST), and others relative to their launch date and development cost. As shown in Figure 1, Flagship mission are typically developed on the order of every 10 years and have a cost greater than $2B fiscal year 2017. The development cost is from the start of preliminary development at the beginning of Phase B through launch and is taken from NASA historical public budget documents and then inflated to fiscal year 2017 equivalent dollars (FY17$). [2, 3] The relatively high cost of Flagship missions is due to their significant complexity with examples such as HST, as it was the largest pointable space telescope of its time, and the James Webb Space Telescope (JWST), which is larger than HST and operates at significantly colder temperatures while still meeting unprecedented stability requirements.

Figure 1. NASA Flagship Mission Cost vs. Launch Date

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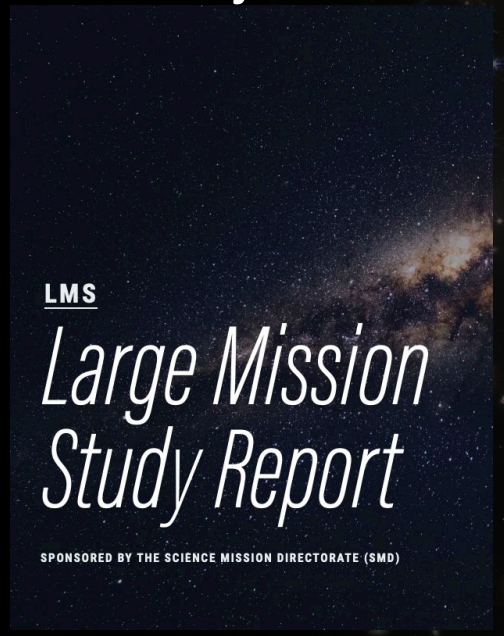
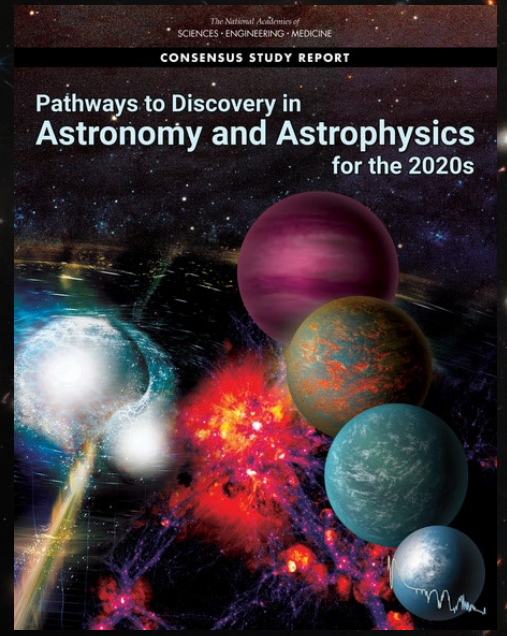
Mission Concept Reports

GAO Report on Major Projects

SMD Internal Study on Flagship Projects



National Academy Recommendations



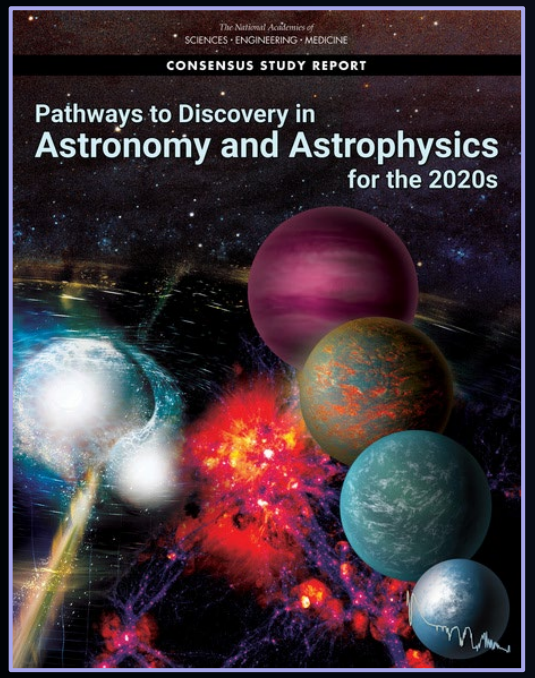
A variety of documents from internal, external, and oversight groups all point to a consistent set of problems & solutions for large/flagship projects, across sectors

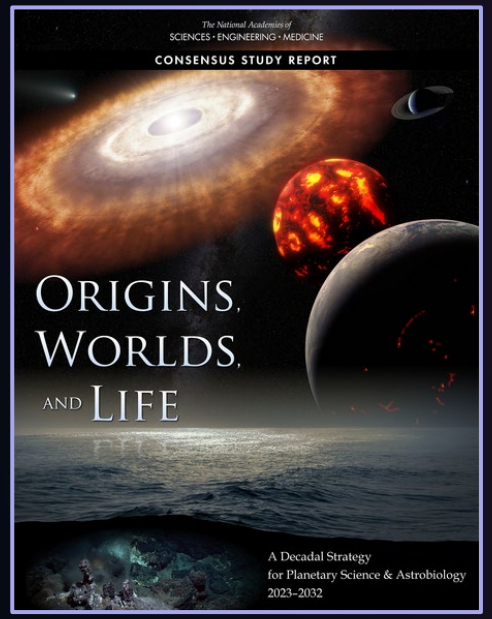
The Habitable Worlds Observatory:

Big Picture Strategy

- **Build to schedule**: Mission Level **1 Requirement - like planetary**
- **Evolve technology from what we have done before**:
  - Build upon current NASA investments and TRL-9 technology
  - Segmented optical telescope system from JWST
  - Coronagraph from Roman‘s coronagraphic imager program
- **Next Generation Rockets**:
  - Larger telescope aperture sizes
  - Leverage opportunities for mass & volume trades
- **Planned Servicing**: Robotic servicing at L2
- **Robust Margins**: Large scientific, technical, and programmatic margins
- **Mature technologies first**: Reduce risk by fully maturing the technologies prior to development phase.

The Science, Technology, Architecture Review Team (START) : Involve the Community





Responsibility: HWO Scope

Objectives:

HWO Goals, objectives, & observations

Quantify all science objectives

Identify performance breakpoints

Build in robust margins

Roadmap Science Traceability Matrix (STM)

Additional Activities:

Mentoring

Super START: Science Analysis

Precursor Science

The HWO START Selection Process

START Co-chair required expertise:

- Leading diverse/inclusive teams
- Leading community-facing initiatives
- Demonstrated knowledge of mission studies
- Experience in HWO-related science/engineering
- Diversity of intellectual expertise and of demographic backgrounds.

START Member required expertise:

- Demonstrated commitment to fostering diverse and inclusive teams
- Commitment to community-facing activities
- Capability to conduct analyses outside team meetings
- Capable to serve as a mentor
- Expertise in HWO-related science/engineering/technology
- Achieve “team balance” with diverse institutions and knowledge base
- Self-identified diversity and input to diversify the START was considered

SELECTED CO-CHAIRS

•Courtney Dressing
•University of California, Berkeley

•John O’Meara
•W. M. Keck Observatory

Link to selection announcement

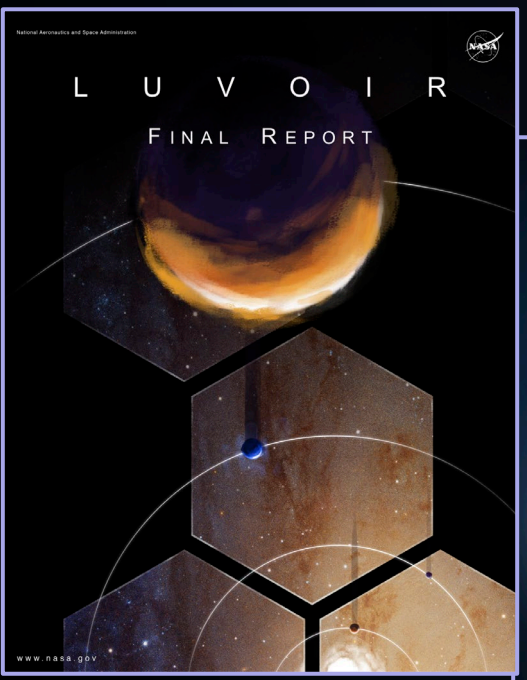
START MEMBERSHIP

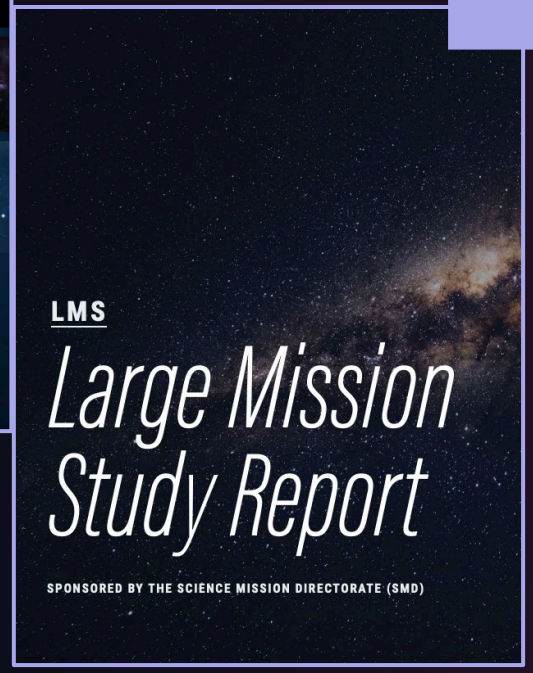
Name	Institution
Charlie Atkinson (ex-officio)	Northrop Grumman
Giada Arney	GSFC
Natasha Batalha	Ames
Eric Burns	LSU
Jessie Christiansen	NExScI
Courtney Dressing **(Co-Chair)**	UC Berkeley
Matthew East (ex-officio)	L3Harris
Kevin France	CU-Boulder
Scott Gaudi	Ohio State University
Renyu Hu	JPL
Alina Kiessling	JPL
Janice Lee	STScI
Bruce Macintosh	UCO
Eric Mamajek (ex-officio)	ExEP

Name	Institution
Alison Nordt (ex-officio)	Lockheed Martin
John O'Meara **(Co-Chair)**	W. M. Keck Observatory
Jim Oschmann	retired
Rachel Osten	STScI
Chris Packham	UTSA
Lynnae Quick	GSFC
Swara Ravindranath (ex-officio)	COR
Jason Rhodes	JPL
Jane Rigby	GSFC
Ty Robinson	U of A
Dmitry Savransky	Cornell University
Evan Scannapieco	ASU
Evgenya Shkolnik	ASU
Erik Wilkinson (ex-officio)	Ball Aerospace

The Technical Assessment Group (TAG):

Involve the Community





Responsibility:

HWO Responsiveness

Objectives:

Evolved Architecture Analyses

Aerospace Landscape Survey

Architecture Trade Deep Dives

Build in Robust Margins

Acting groups:

The TAG + Mentoring

Super TAG: Engineering Analysis

Aerospace Landscape Teams

Architecture Trades Teams

The HWO TAG

SELECTED NASA CO-CHAIRS

Goddard Space Flight Center

•**Lee Feinberg**
Co-Chair Engineer

Aki Roberge
Co-Chair Scientist

Jet Propulsion Laboratory

John Ziemer
Engineer Co-Chair

Bertrand Mennesson
Co-Chair Scientist

The TAG Selection Process:

TAG Co-chair required expertise:

- Leading diverse/inclusive teams
- Leading community-facing initiatives
- Demonstrated knowledge of mission studies
- Experience in HWO-related science/engineering
- Intellectual & demographic diversity

TAG Member expertise:

- Demonstrated commitment to fostering diverse and inclusive teams
- Commitment to community-facing activities
- Capability to conduct analyses outside team meetings
- Capable to serve as a mentor
- Expertise in HWO-related science/engineering/technology
- Intellectual & demographic diversity

Technical Assessment Group (TAG)

What architecture trades remain?

How are those trades related/coupled to each other?

Which trades are the most important to study now?

What are the technologies associated with those trades?

What cost/schedule risks exist for those trades?

How might those risks be mitigated?

How can external partners be involved?

TAG Membership

Name	Institution
Ruslan Belikov	ARC
Matthew Bolcar	GSFC
Jason Derleth (ex-officio)	COR
Lee Feinberg (Eng. Co-Chair)	GSFC
Kevin Fogarty	ARC
Jessica Gaskin	MSFC
Thomas Greene	ARC
Brian Kern	JPL
Marie Levine	JPL
Alice Liu	GSFC
Sangeeta Malhotra	GSFC
Dimitri Mawet	JPL
Michael McElwain	GSFC
Bertrand Mennesson (Sci. Co-Chair)	JPL

Name	Institution
Michael Menzel	GSFC
Patrick Morrissey	JPL
Niki Parenteau	ARC
David Redding	JPL
Aki Roberge (Sci. Co-Chair)	GSFC
Stuart Shaklan	JPL
Nick Siegler (ex-officio)	ExEP
Breann Sitarski	GSFC
Philip Stahl	MSFC
Christopher Stark	GSFC
Julie van Campen	GSFC
Feng Zhao	JPL
John Ziemer (Eng. Co-Chair)	JPL
TBA member - deferred start date	JPL

HWO START/TAG Face to Face Meeting
Oct 31 – Nov 2

Day 1:

- Welcome! Goals for START/TAG. Mission development and systems engineering intro. HabEx/LUVOIR review.
  Breakout: What excites you about HWO? What are our 1-year goals?

Day 2:

- Lessons from JWST & Roman for HWO. Lessons from industry expertise.
  Breakout: Identify key questions across START/TAG & initial working groups.

Day 3:

- Mentorship program and workforce development workshop.
  Breakout: What approaches, programs and resources do we have for IDEA?
  Breakout: What are our audiences, messages, and plans for communication?

HWO Splinter Session @ AAS
Date/Time TBD

"One-stop shopping for HWO breakouts"

We plan to invite talks from the following groups:

- START
- TAG
- Technology roadmap teams
- Other working groups (e.g., yields team)
- Lightning talks from relevant SAT grants
- Lightning talks from Precursor Science grants
- NGO-relevant SAG's
- PAG's

… plus lots of discussion time!

Broad Engagement with HWO

Community Activities

- Program Analysis Groups
  - Science Analysis Groups
  - Science Interest Groups
- Public portions of START/TAG meetings

NASA-formed groups

- Science, Technology, Architecture Review Team
- Technical Assessment Team
- START/TAG Working Groups
- Mentorship program (details TBD)

Competed Calls

- Astrophysics Decadal Survey Precursor Science (ROSES)
- Strategic Astrophysics Technologies (ROSES)
- EPRV Foundation Science (ROSES)
- Future technology calls (ROSES)
- Future architecture deep dive calls (TBD)

IDEA for GOMAP

Now:

- Incorporate IDEA into START and TAG meetings and activities. Specific plans to be worked with co-leads and ultimately members of those groups. For details, tune into the face-to-face meeting. (Especially day 3!)

Long-term:

- Develop IDEA plan for HWO. Would like to work with external partners on this to institute “one-team culture” on HWO, and to help ensure IDEA principles are present throughout project.

Questions and more information

NASA Astrophysics Statement of Principles:
go.nasa.gov/3Kwn07s

NASA GOMAP website:
go.nasa.gov/4107ZzC

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shawn.goldman@nasa.gov

BACKUP:

Broad Engagement with HWO