

Title: Amber Straughn: A New Era in Astronomy: NASA's James Webb Space Telescope

Date: Mar 01, 2017 07:00 PM

URL: <http://pirsa.org/17030000>

Abstract: <p>The Hubble Space Telescope has completely revolutionized our understanding of the universe, and has become a beloved icon of popular culture. As revolutionary as Hubble has been, we have pushed it to its scientific limits in many ways. Hubble's successor, the James Webb Space Telescope, has been in the works for almost two decades and is scheduled to launch in late 2018. It will be 100 times more powerful than Hubble. In her Perimeter Public Lecture, Dr. Amber Straughn will provide an update on the progress of building the world's largest-yet space telescope, and will give an overview of the astronomical questions we hope to answer with Webb. These questions get to the heart of what it means to be human: Where did we come from? How did we get here? Are we alone?</p>

Beyond Hubble: A New Era of Astrophysics with NASA's James Webb Space Telescope



Dr. Amber Straughn

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NASA's Goddard Space Flight Center

@astraughnomer

#JWST

Perimeter Institute for Theoretical Physics

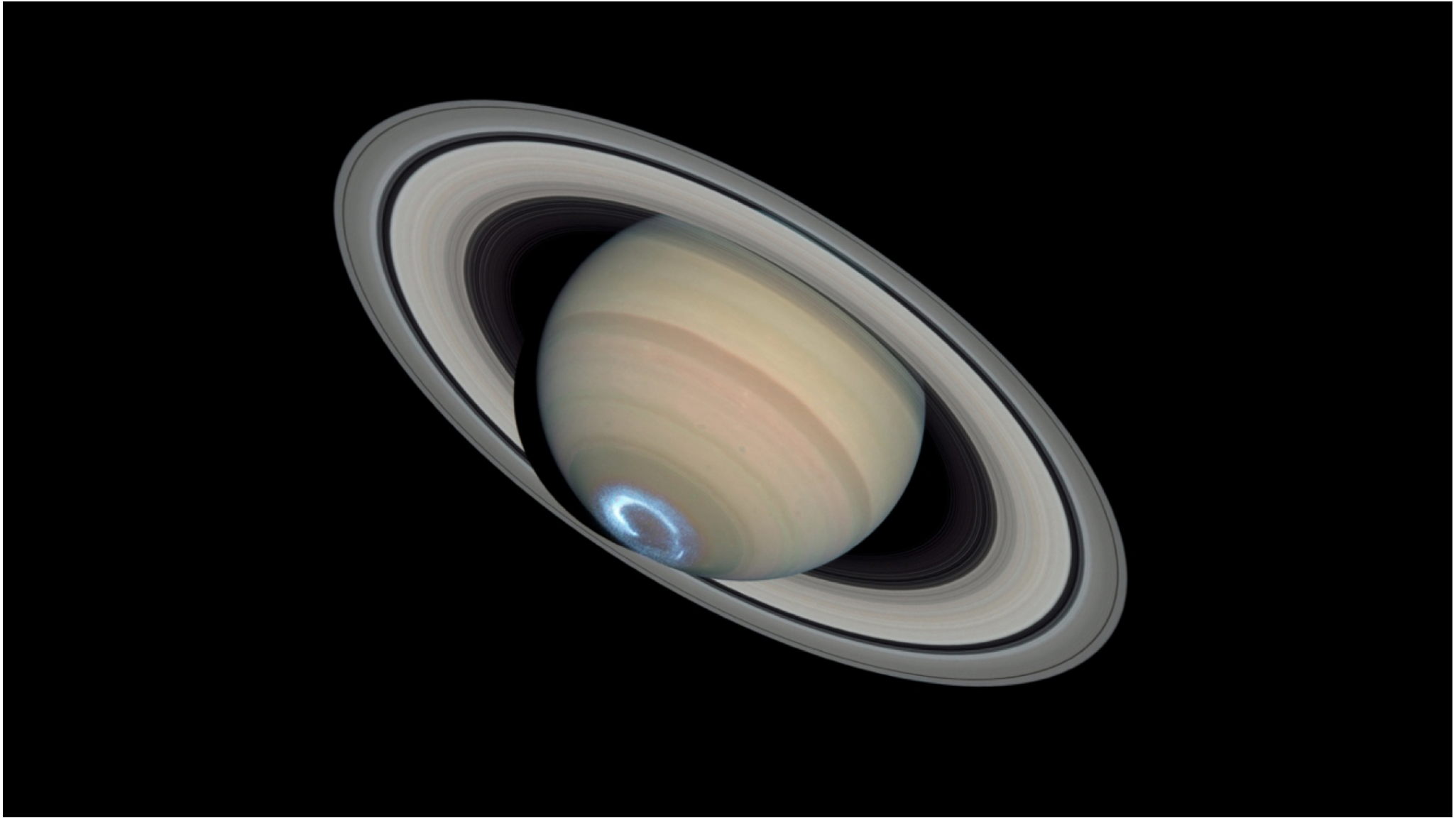
2017 March 1

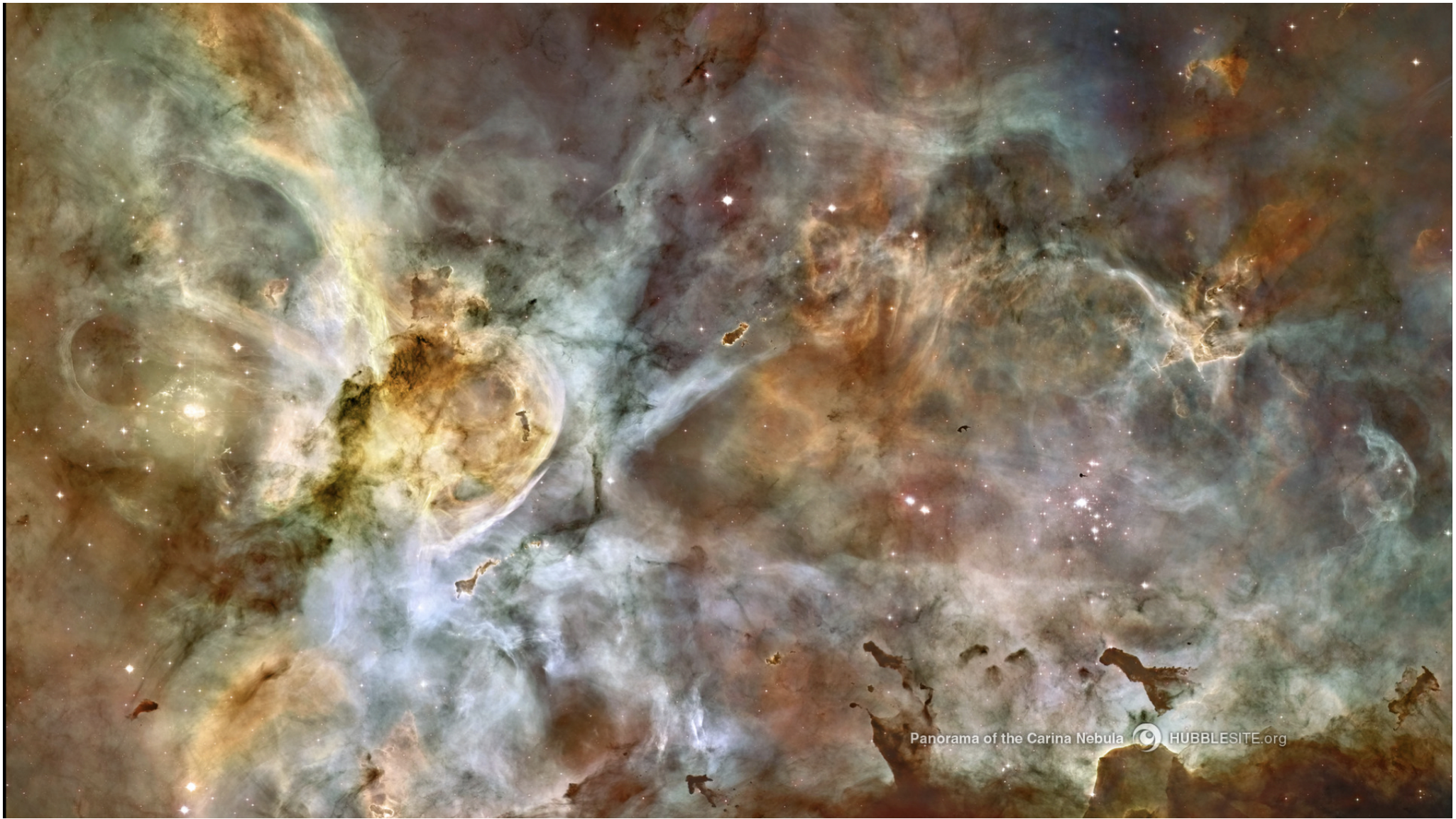



Where did we come from?

How did we get here?

Are we alone?





Panorama of the Carina Nebula  HUBBLESITE.org



NGC 3603  HUBBLESITE.org







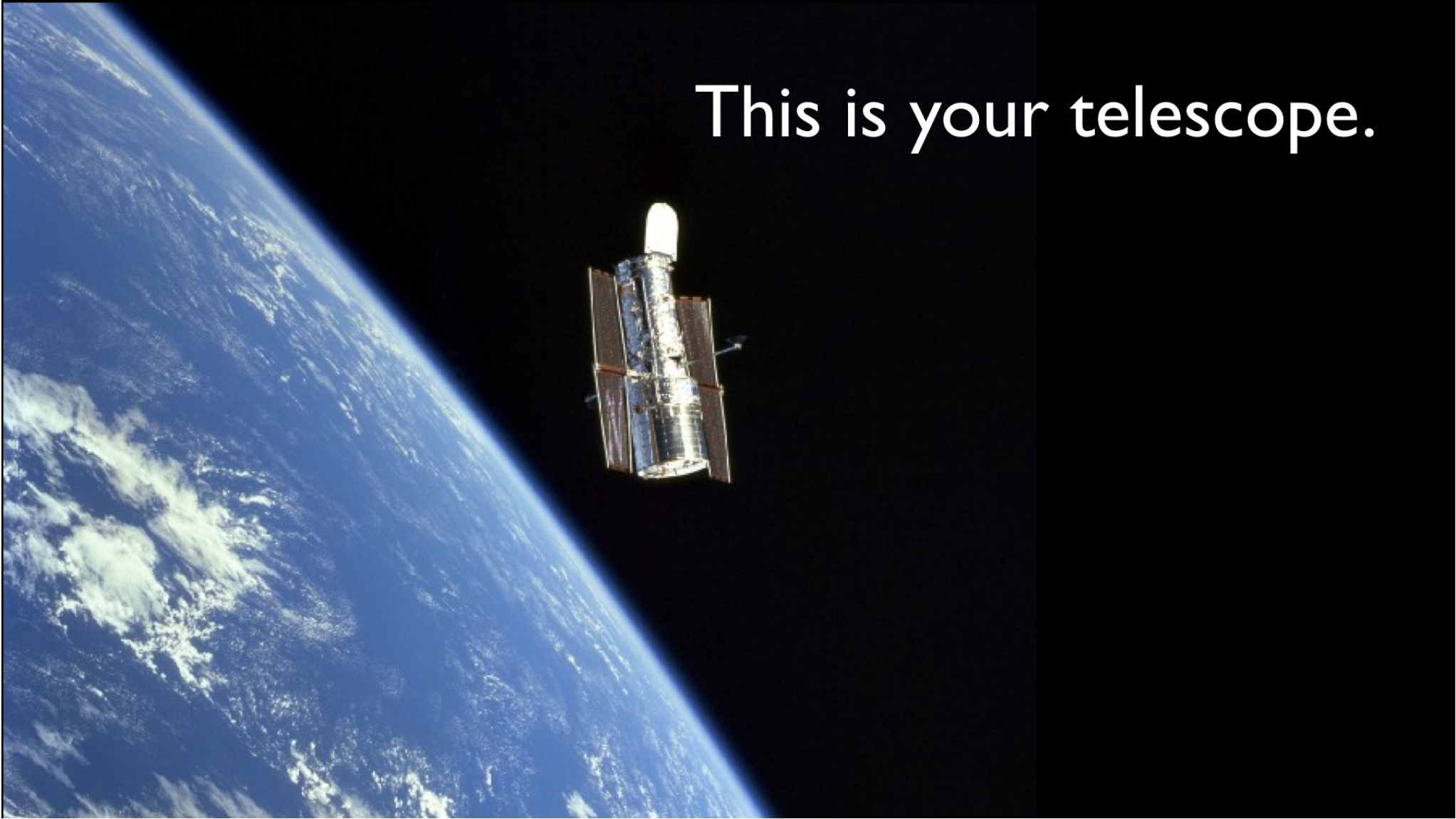








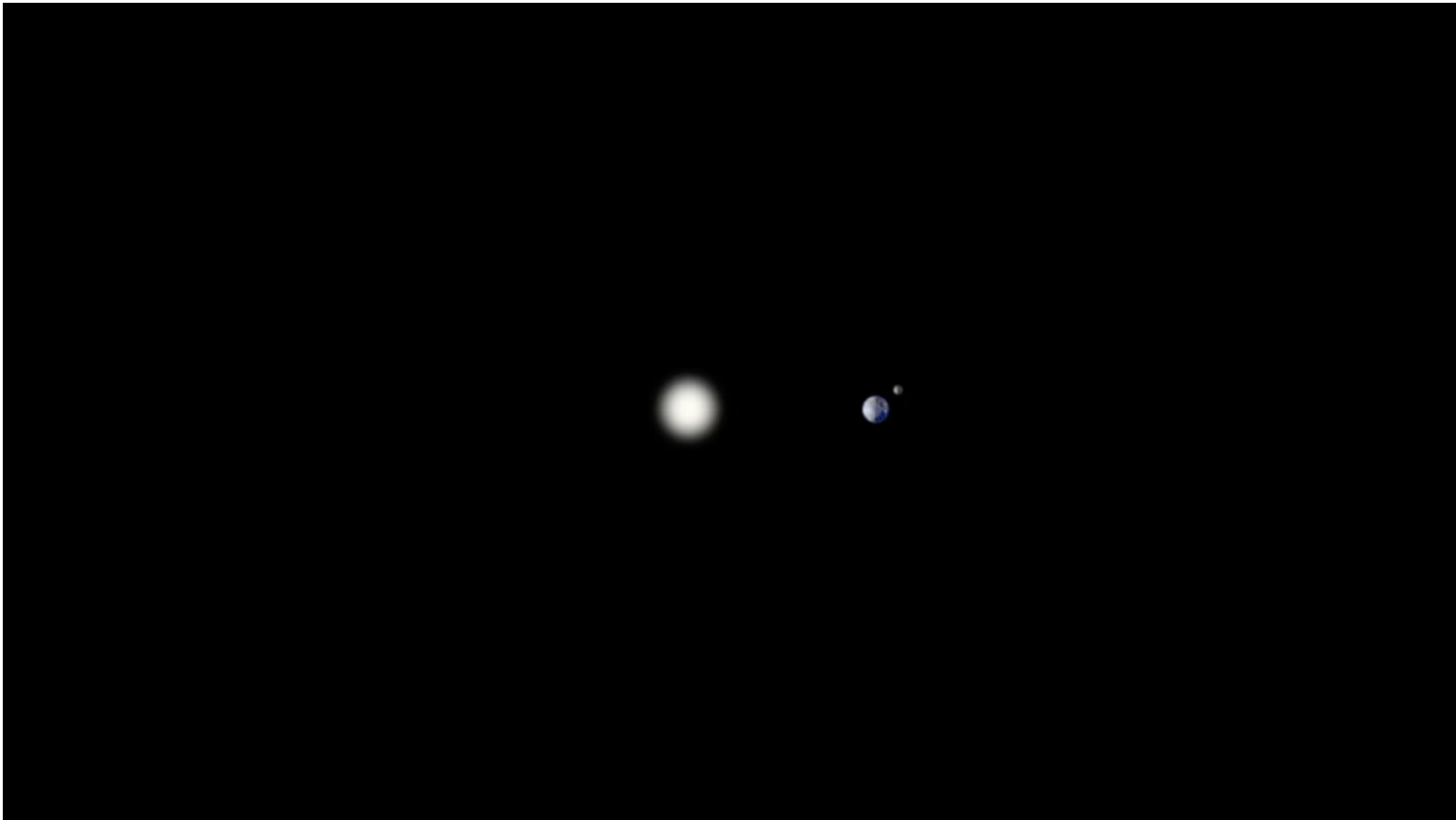
This is your telescope.

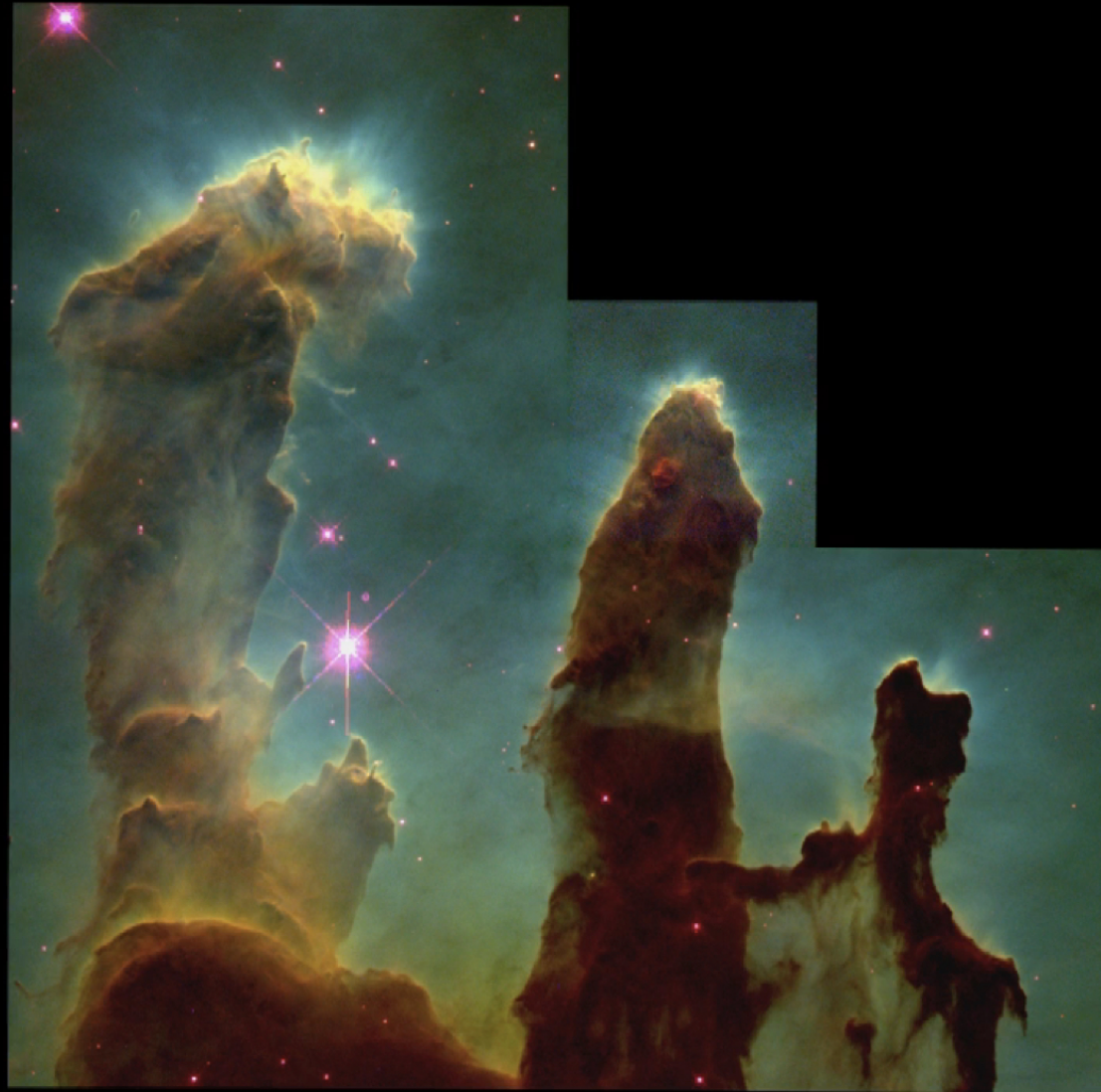




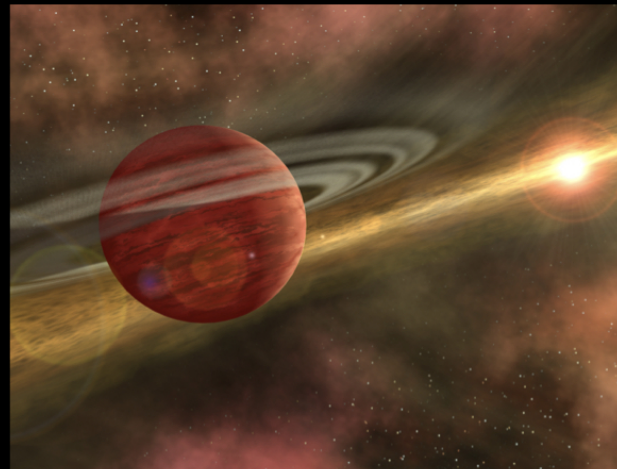
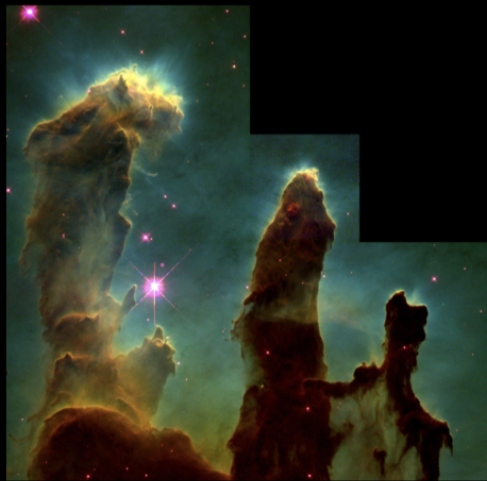
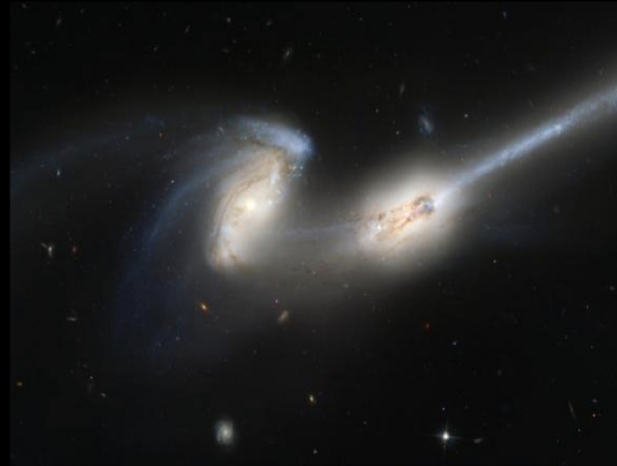








Science Themes for JWST



First Light & Reionization





First Light & Reionization

What Are the First Galaxies?

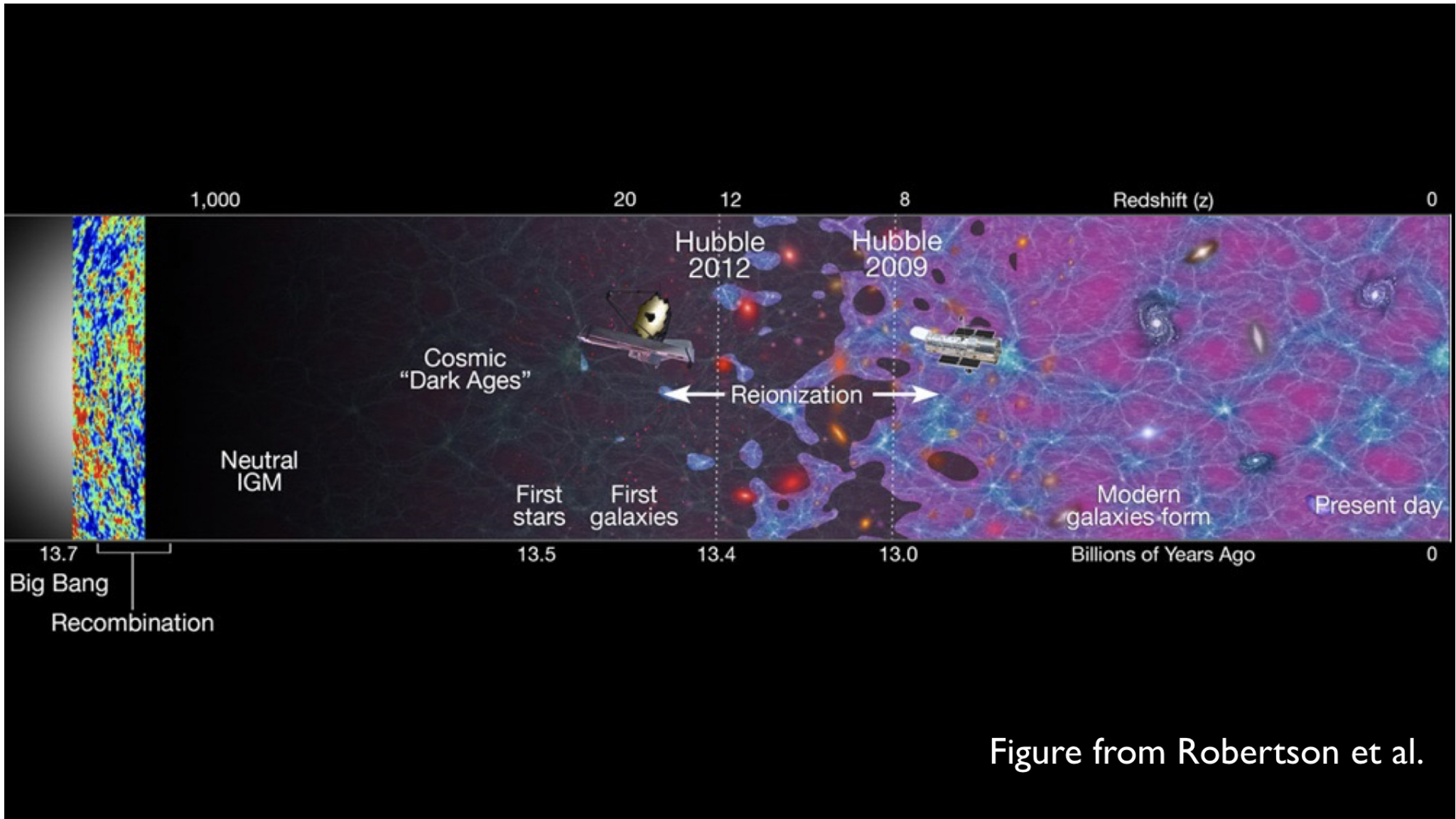
- When did the first luminous sources arise and what was their nature?
- What were their clustering properties?

When and How Did Reionization Occur?

- Was reionization a single event?
- What is the ionization history of the universe prior to the final reionization?

What Sources Caused Reionization?

- What were the sources responsible for reionization?
- Were they powered by nuclear fusion or gravitational accretion?
- How is the evolution of galaxies and black holes affected by the possibly extended period of reionization?



Galaxy Assembly



When and How Did the Hubble Sequence Form?

- Where were stars in the Hubble Sequence galaxies formed?
- When did luminous quiescent galaxies appear?
- How does this process depend on the environment?

How did the Heavy Elements Form?

- Where and when are the heavy elements produced?
- To what extent do galaxies exchange material with the intergalactic medium?

What Physical Processes Determine Galaxy Properties?

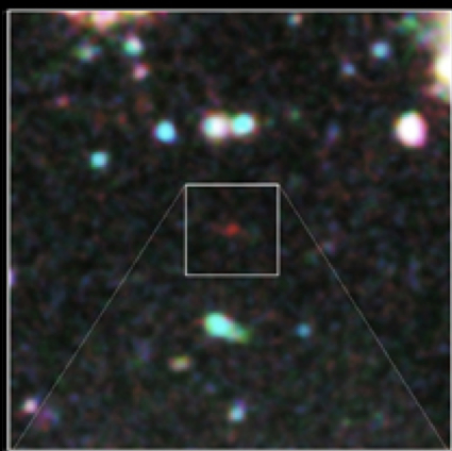
- When and how are the global scaling relations for galaxies established?
- Do luminous galaxies form through the hierarchical assembly of dark matter halos?

What are the Roles of Starbursts and Black Holes in Galaxy Evolution?

- What are the redshifts and power sources of the high-redshift ultra-luminous infrared galaxies (ULIRGs)?
- What is the relation between the evolution of galaxies and the growth and development of black holes in their nuclei?

How did we go from

This

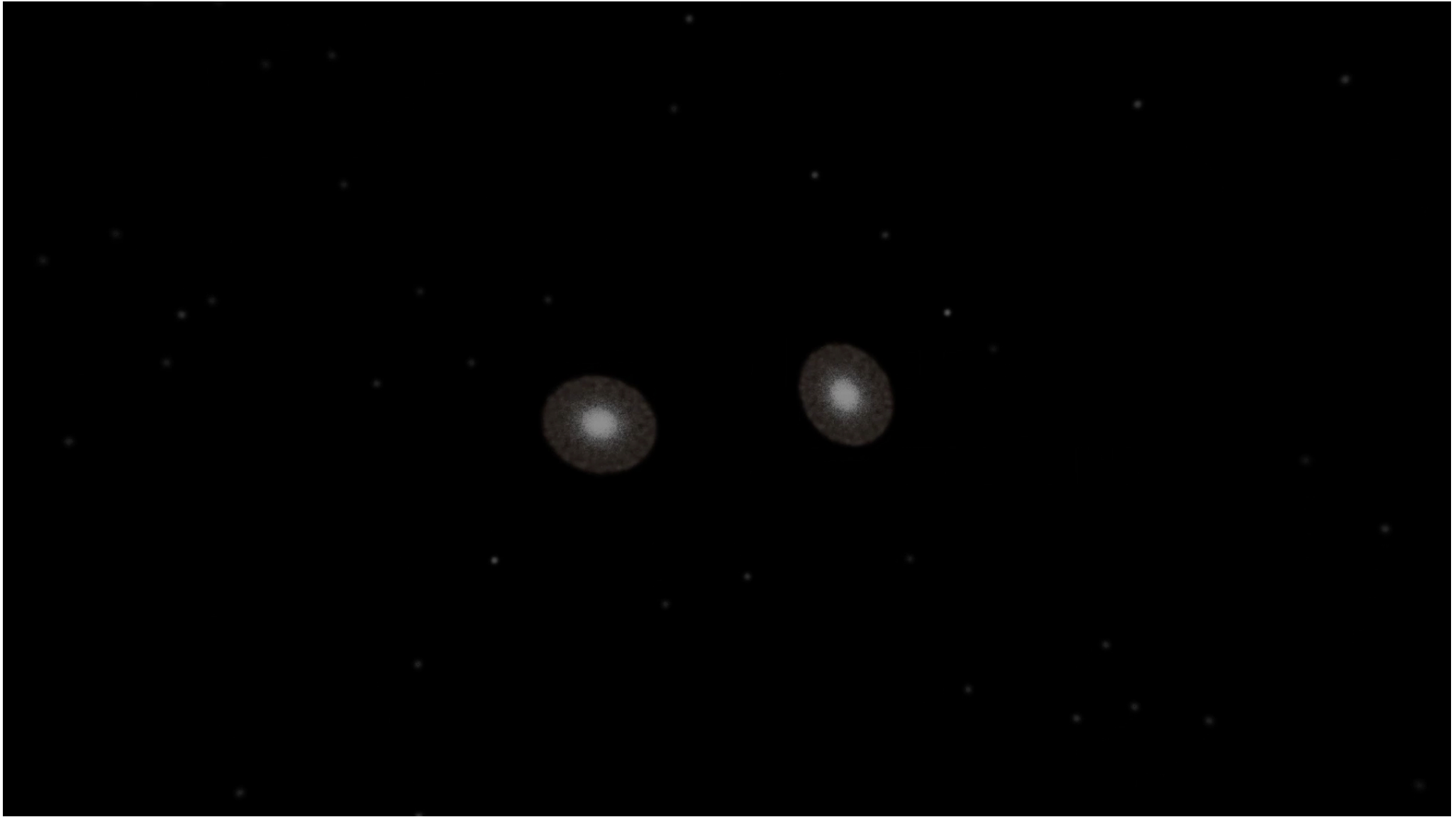


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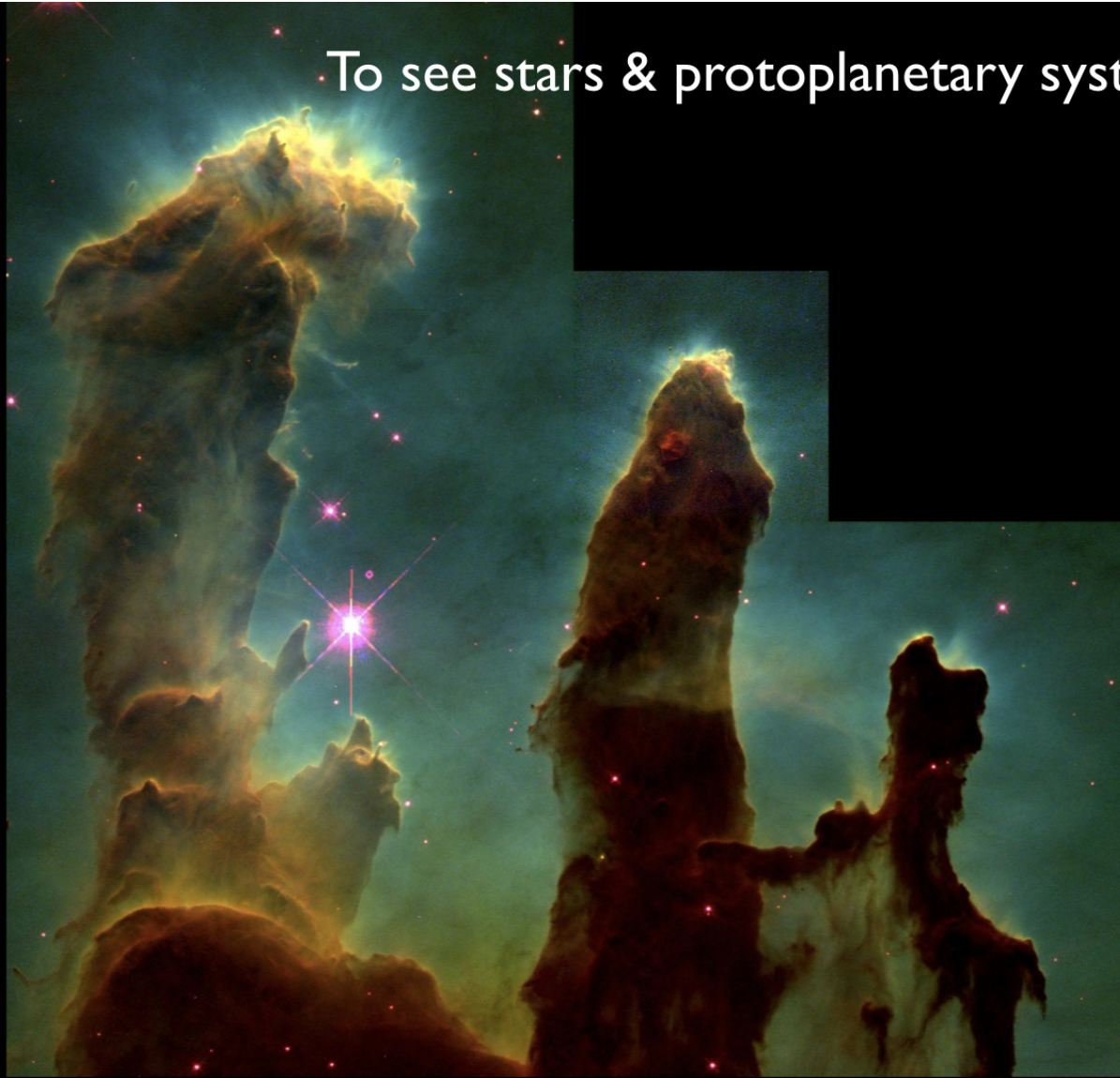
to this?







To see stars & protoplanetary systems being born





To see stars & protoplanetary systems being born

How do Protostellar Clouds Collapse?

- How do clouds of gas and dust collapse down to the dense cores that form stars?
- What is the early evolution of protostars?

How Does Environment Affect Star Formation and Vice Versa?

- How do very massive stars form?
- How do stellar winds and ionizing radiation from massive stars affect nearby star formation?

How do Protoplanetary Systems Form?

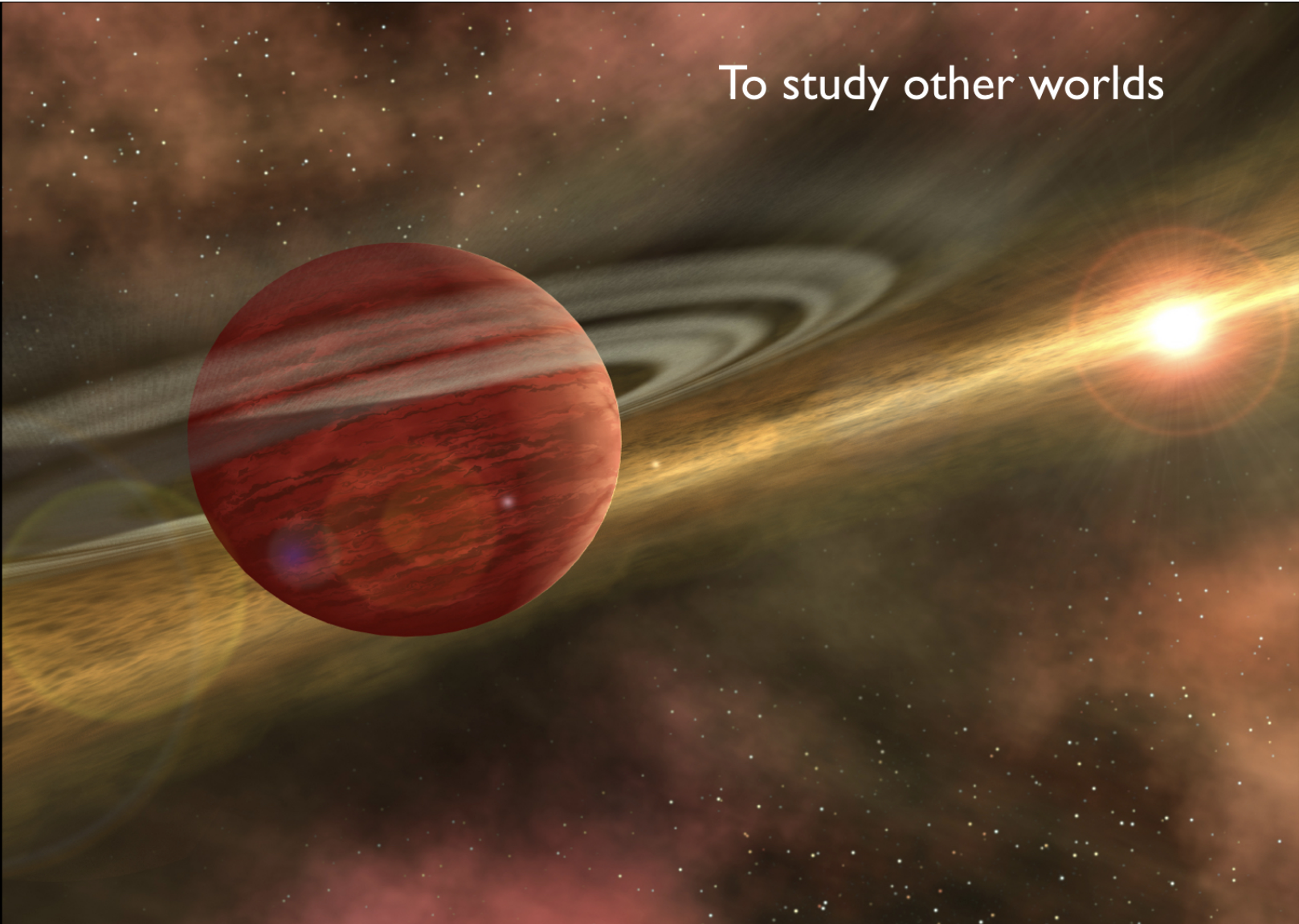
- How do circumstellar disks form and evolve?
- What determines their physical sizes?
- How do dust grains within the disks form planets?

What are the life cycles of gas and dust?

- How do gas-phase molecules interact with dust grains in quiescent cloud cores?
- How does the formation of a star and planetary system affect the astrochemical evolution of the gas and dust?
- What is the origin of water and organic materials in a planetary system?



To study other worlds



To study other worlds

How Do Planets Form?

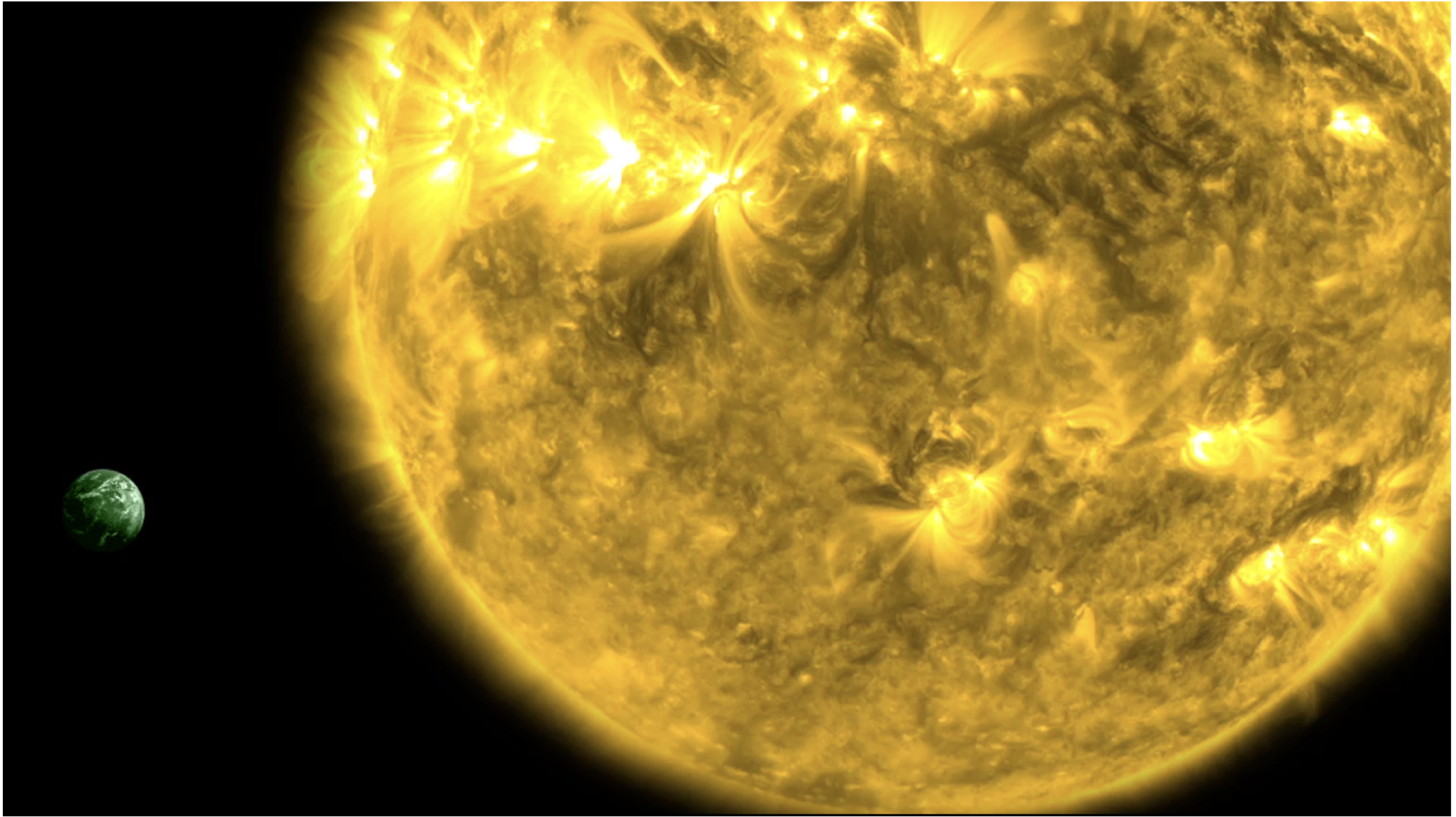
- What are the physical processes that lead to planets?
- How common are giant planets and what is the distribution of their orbits?
- How do giant planets affect the formation of terrestrial planets?

How Are Circumstellar Disks Like Our Solar System?

- What comparisons, direct or indirect, can be made between our Solar System, circumstellar disks (forming solar systems), and remnant disks?

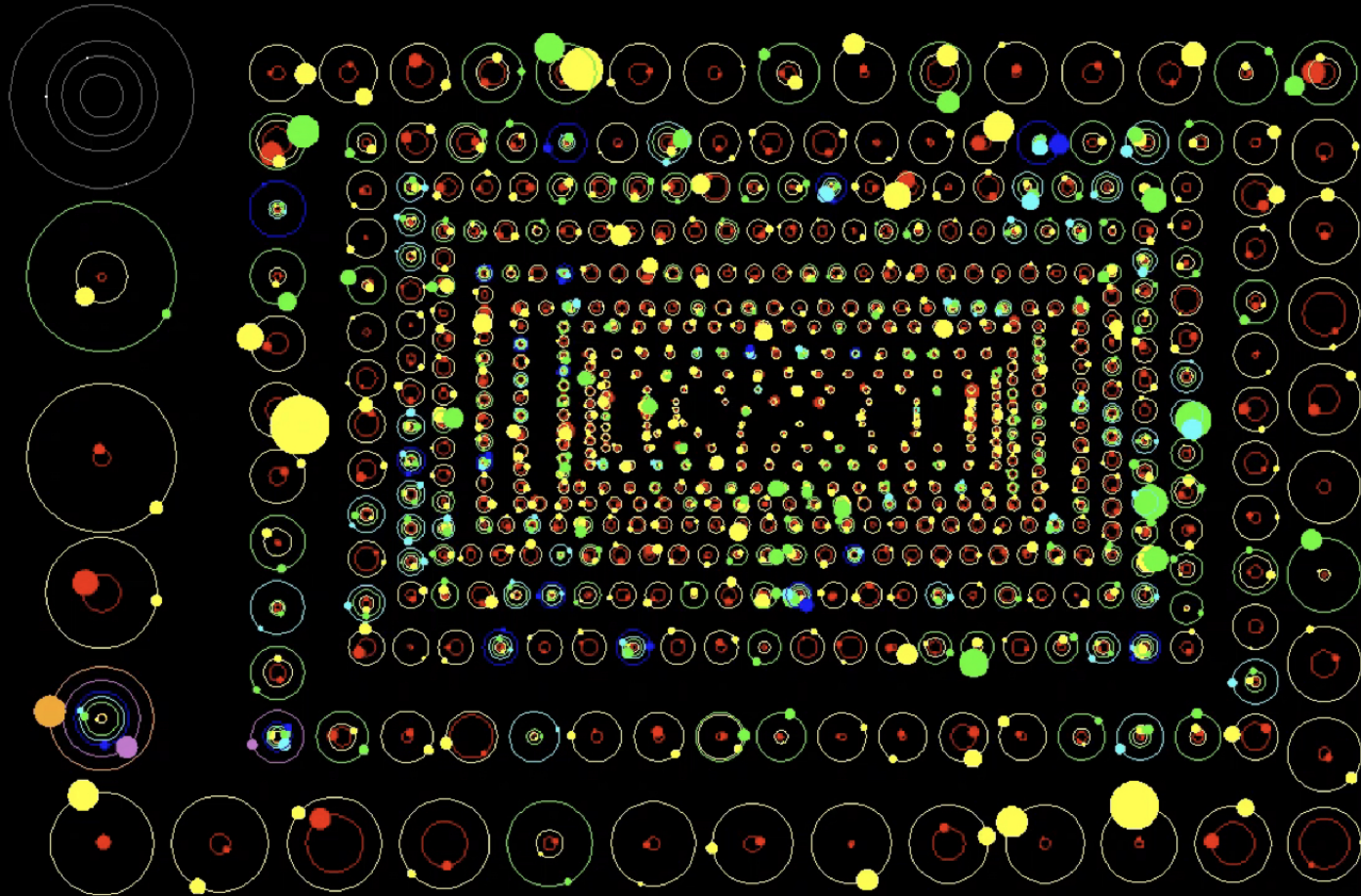
How Are Habitable Zones Established?

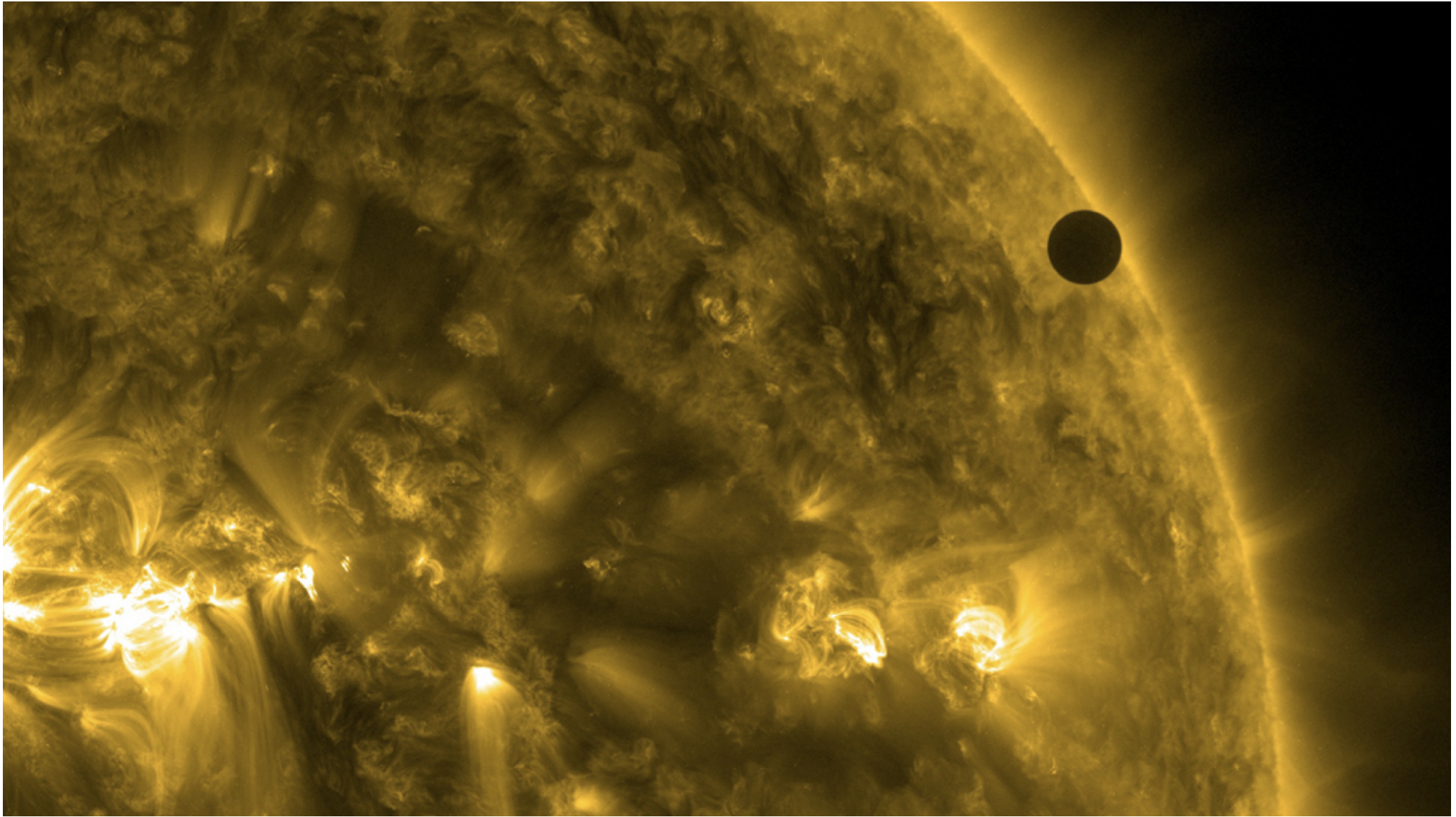
- What are the sources of water and organics for planets in habitable zones?
- How are systems cleared of small bodies?
- What are the planetary evolutionary pathways by which habitability is established or lost?
- Does our Solar System harbor evidence for steps on these pathways?



The Kepler Orrery III

$t[\text{BJD}] = 2455215$

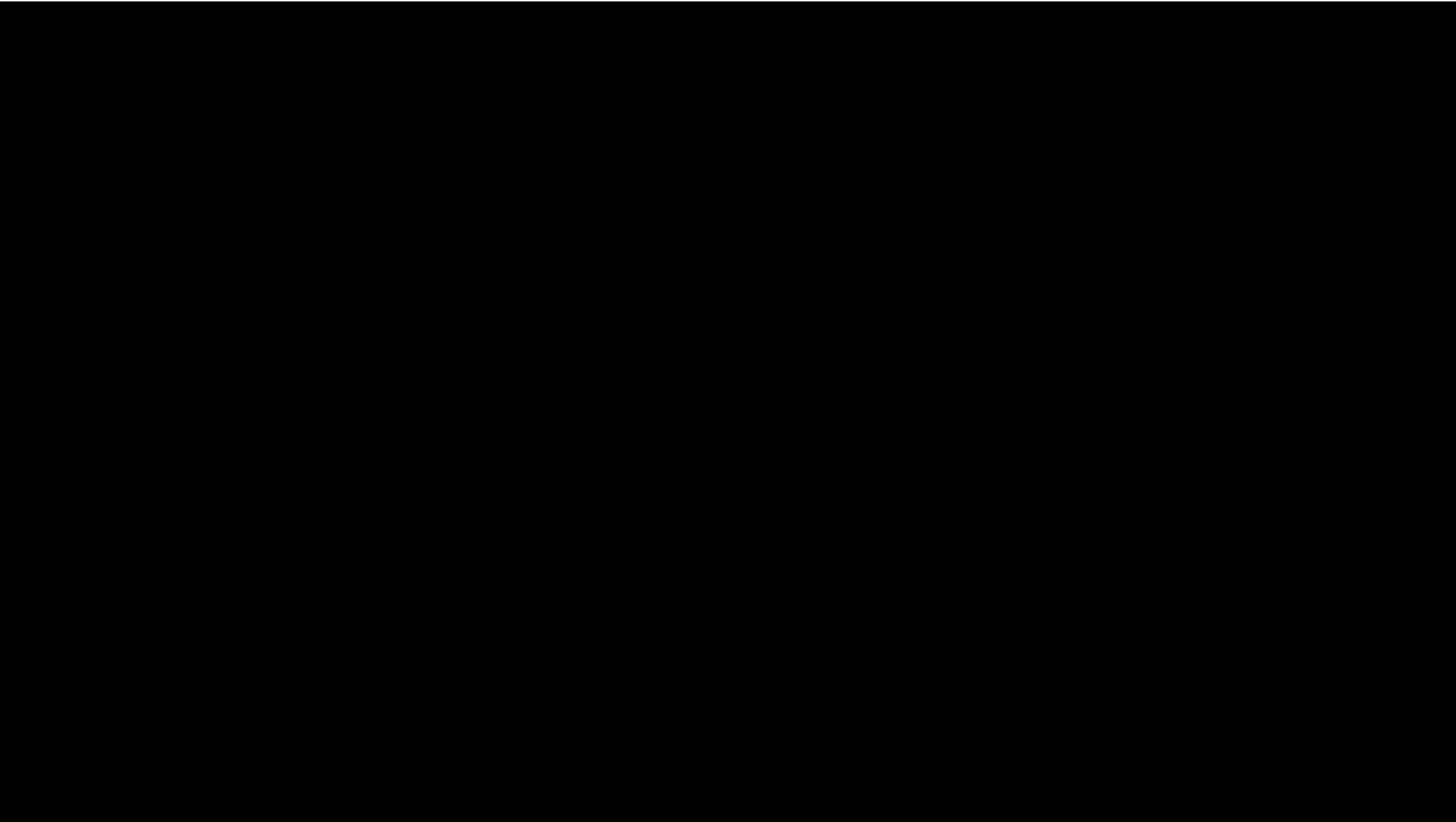




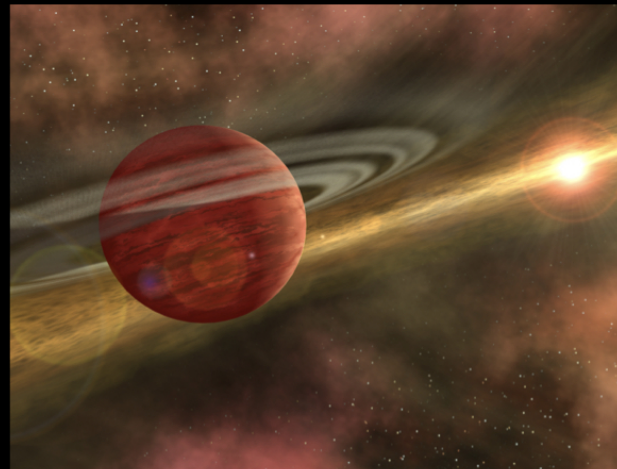
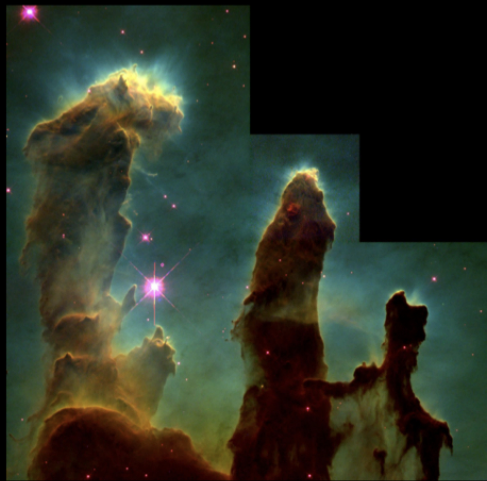
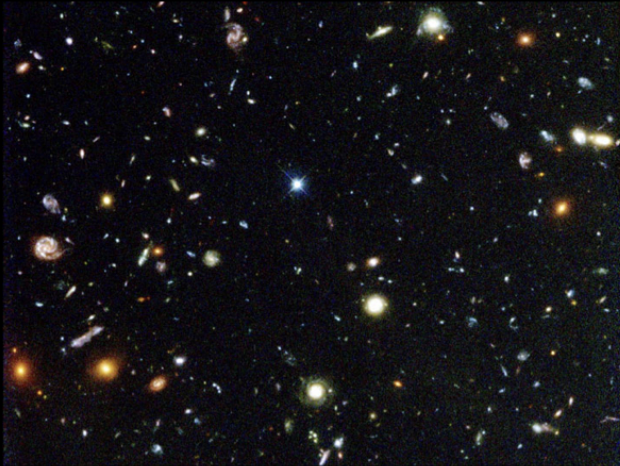
TRAPPIST-1 System



Illustration



Science Themes for JWST

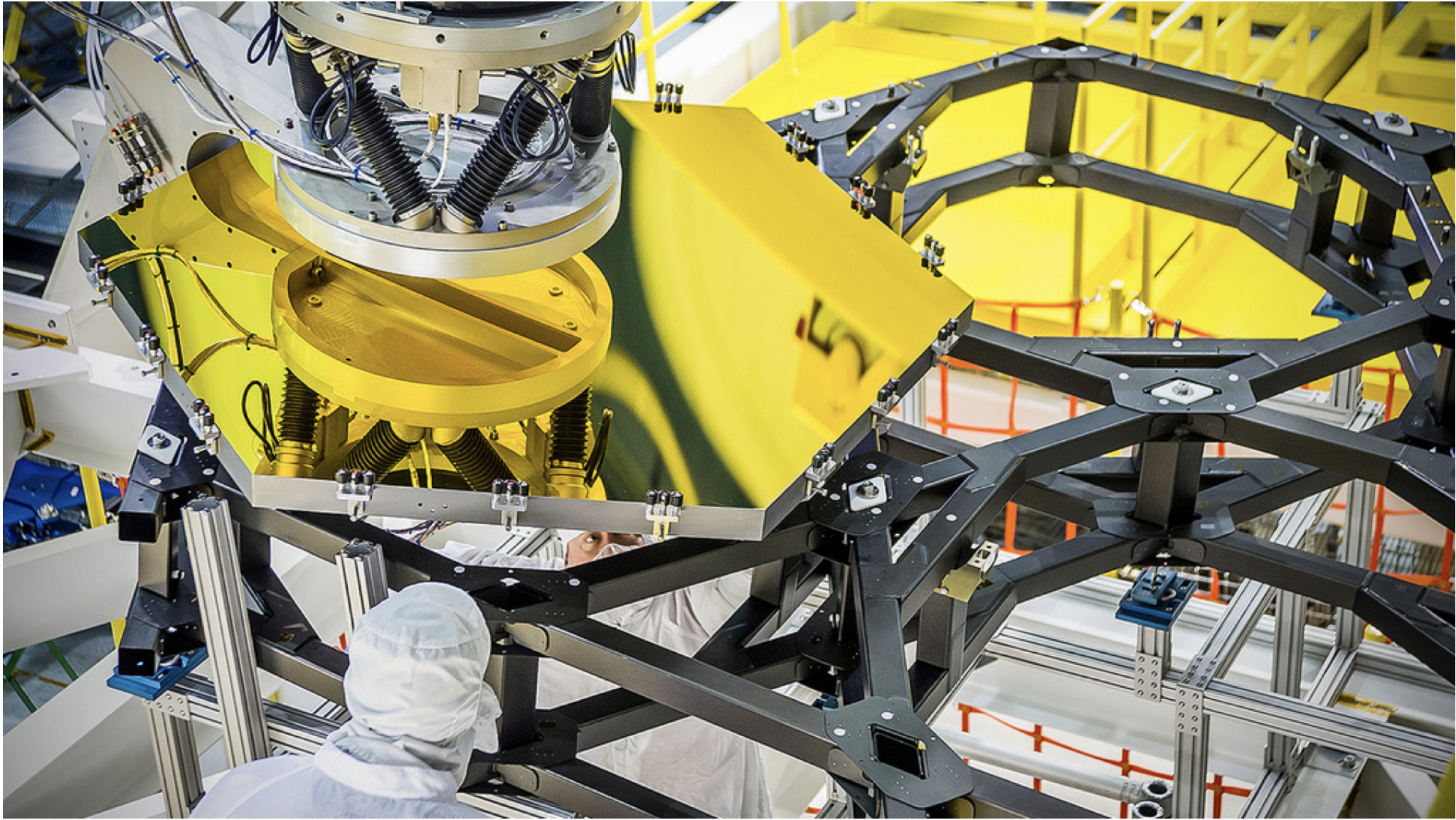


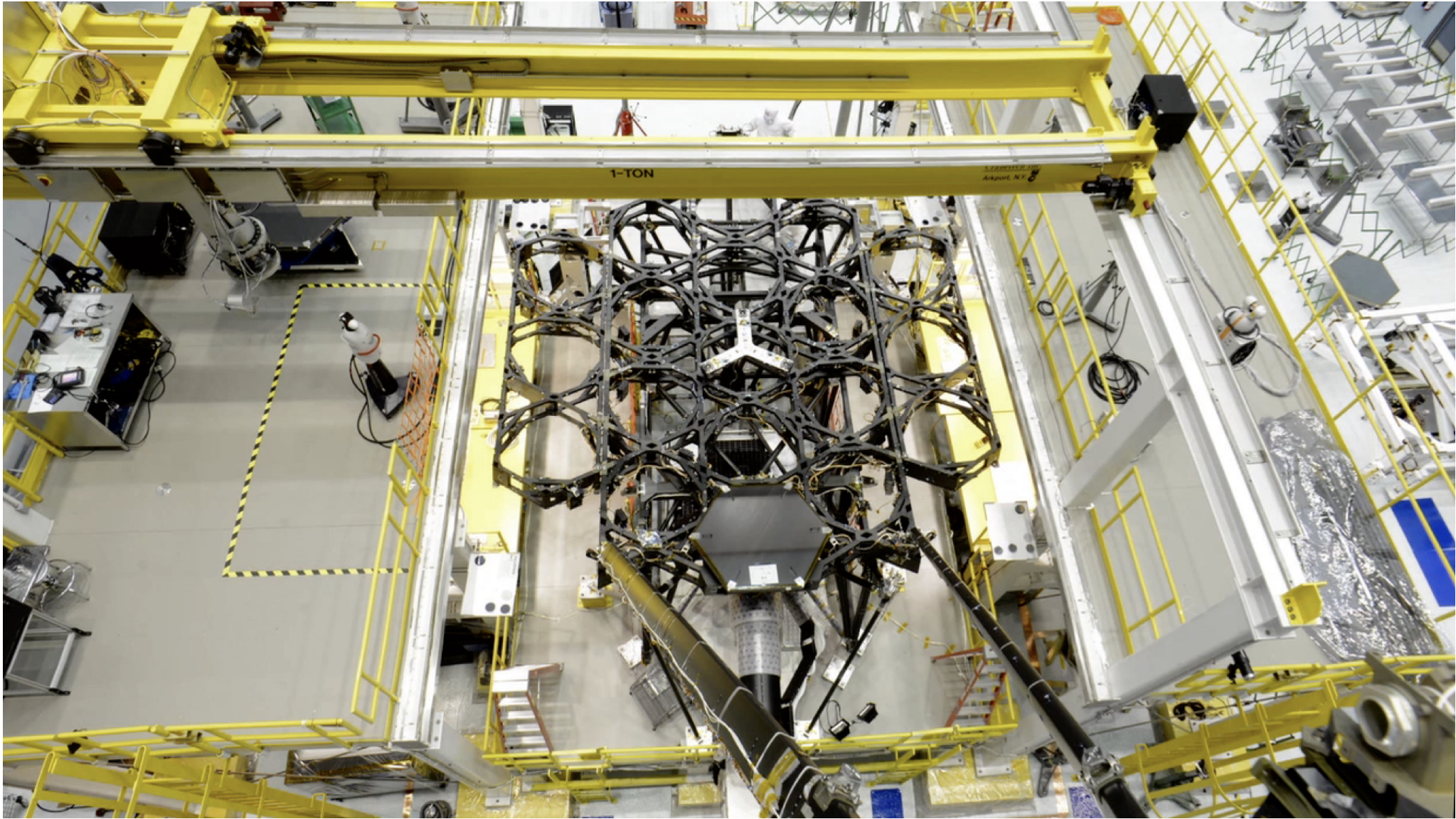


#JWST

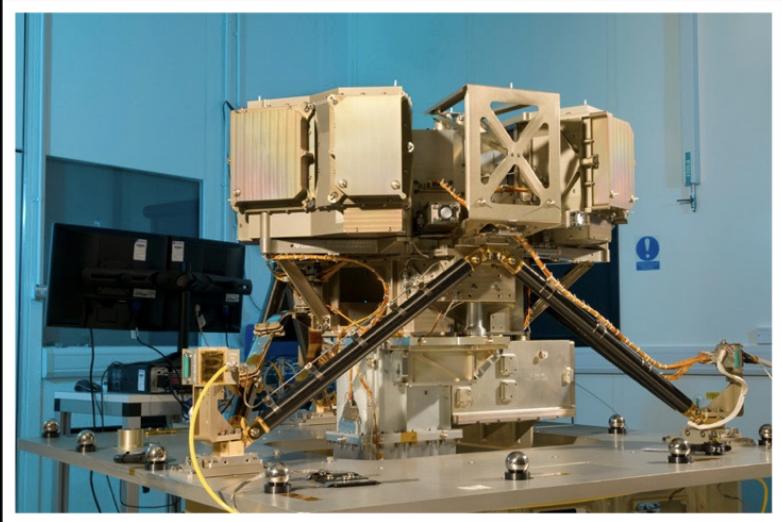
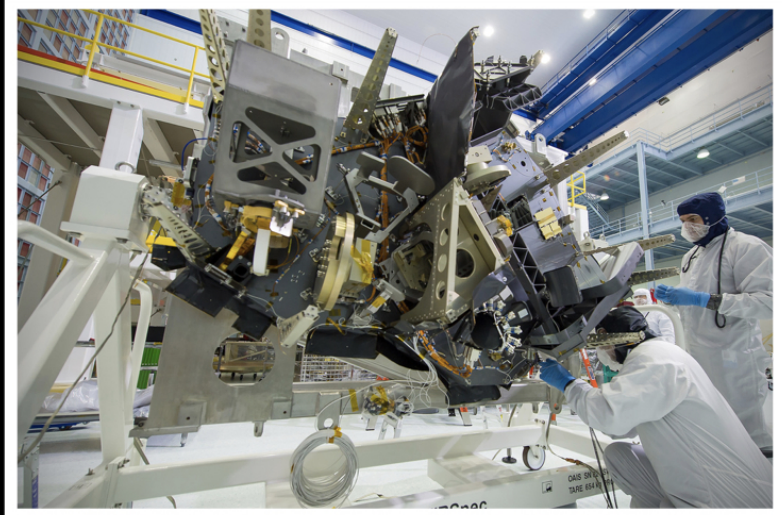
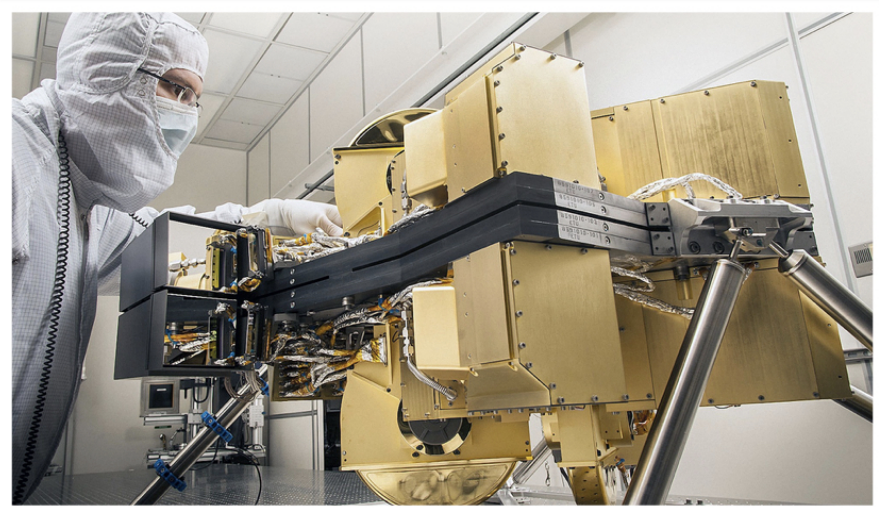




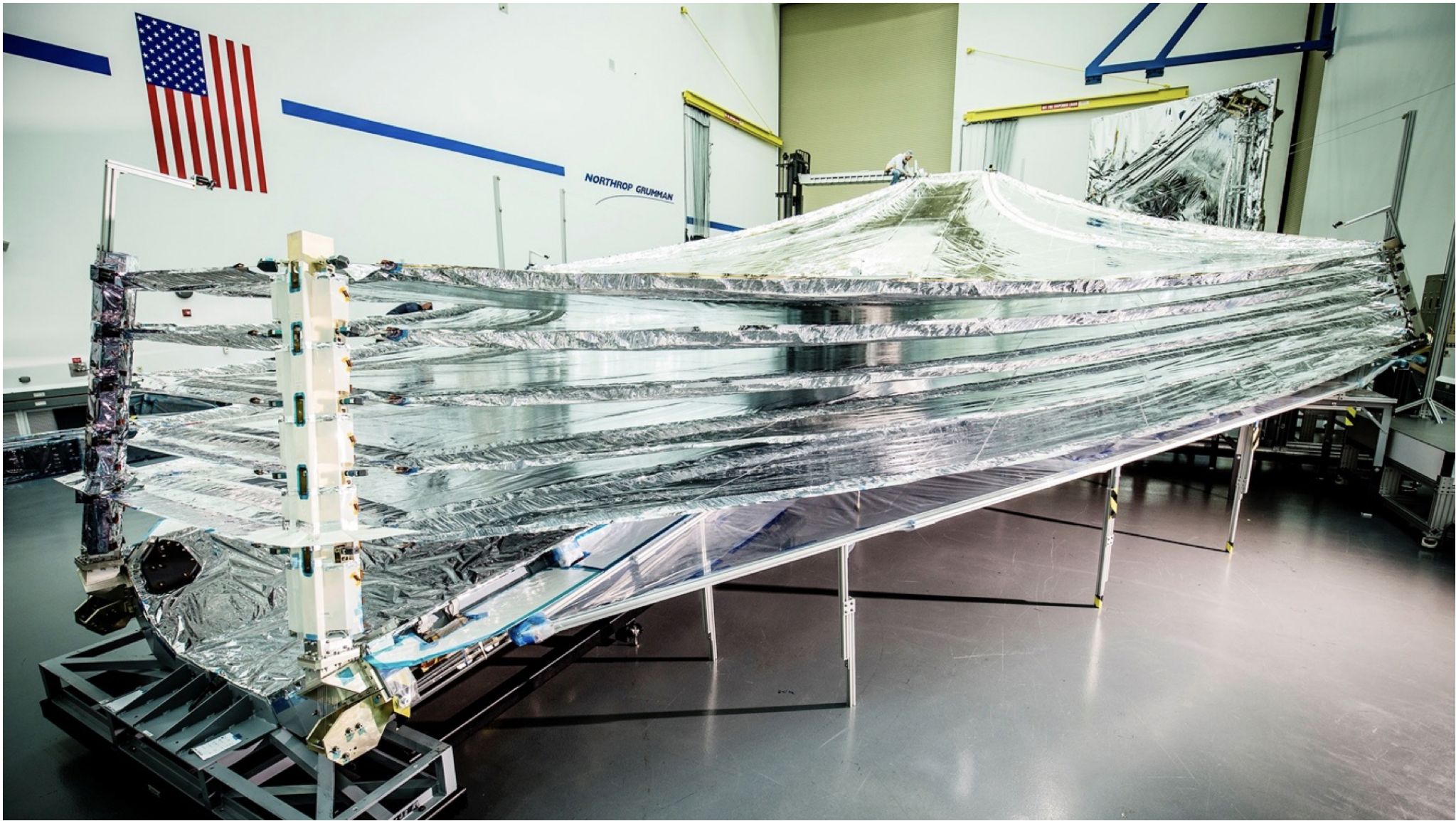


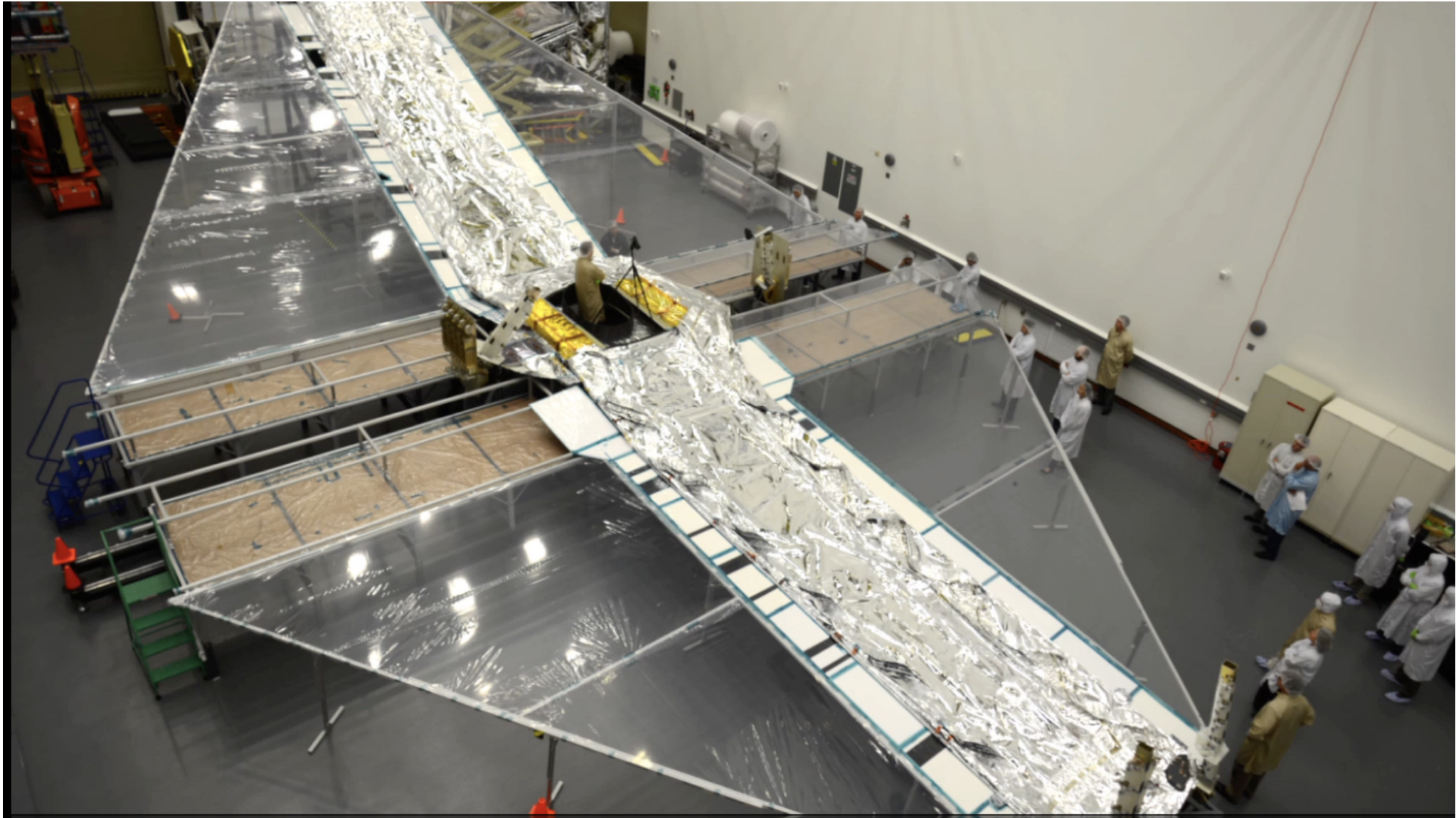












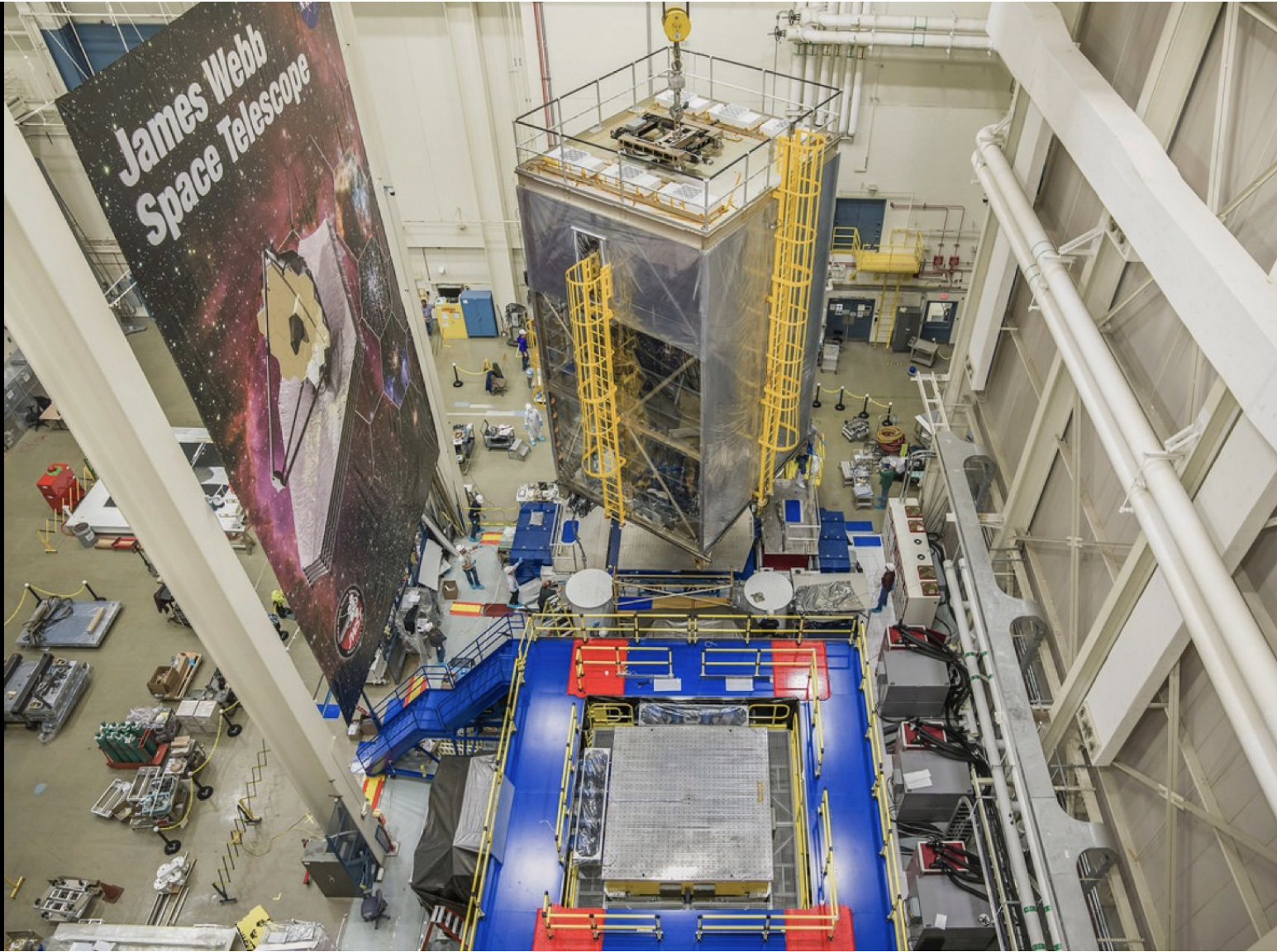


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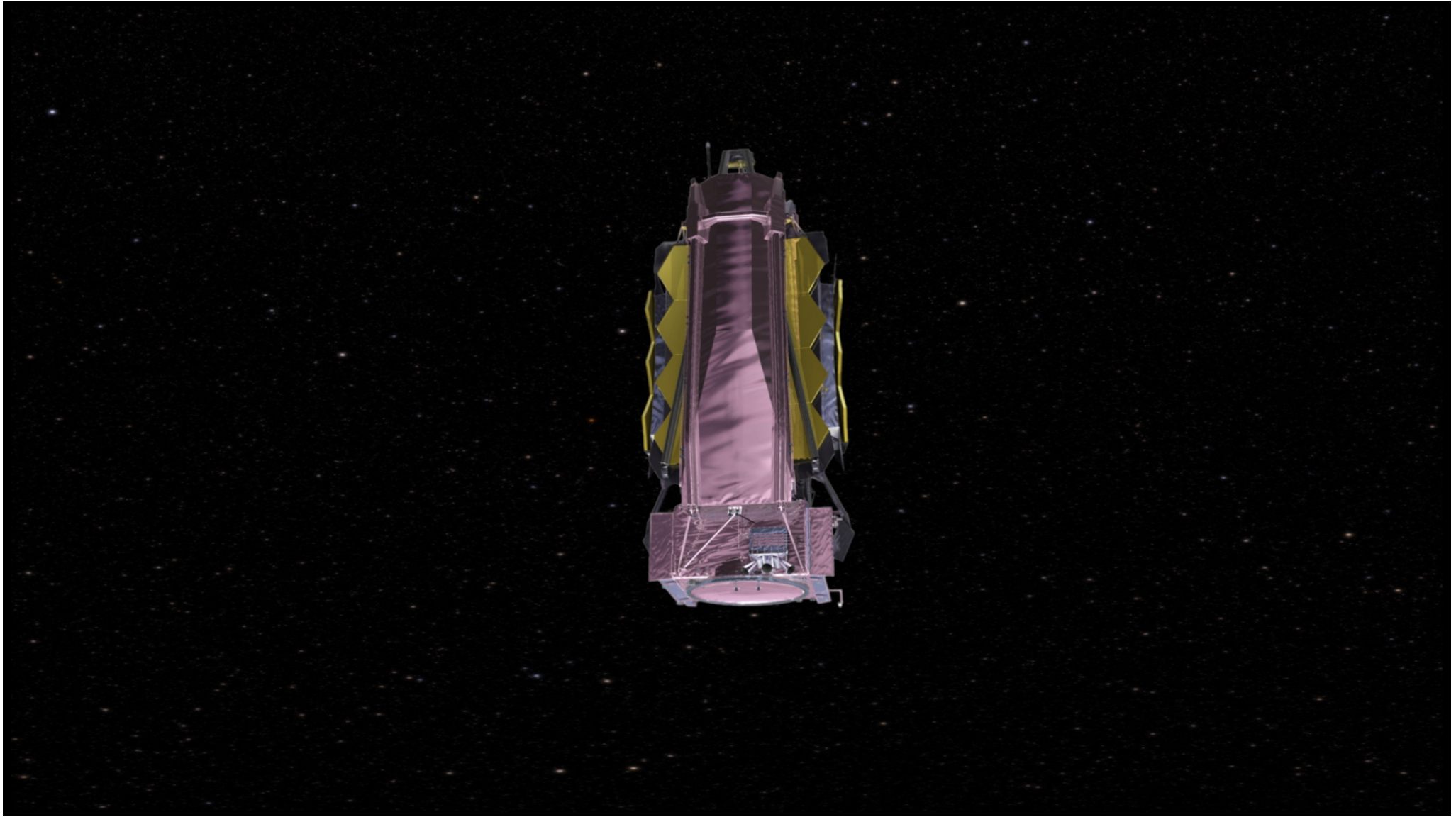








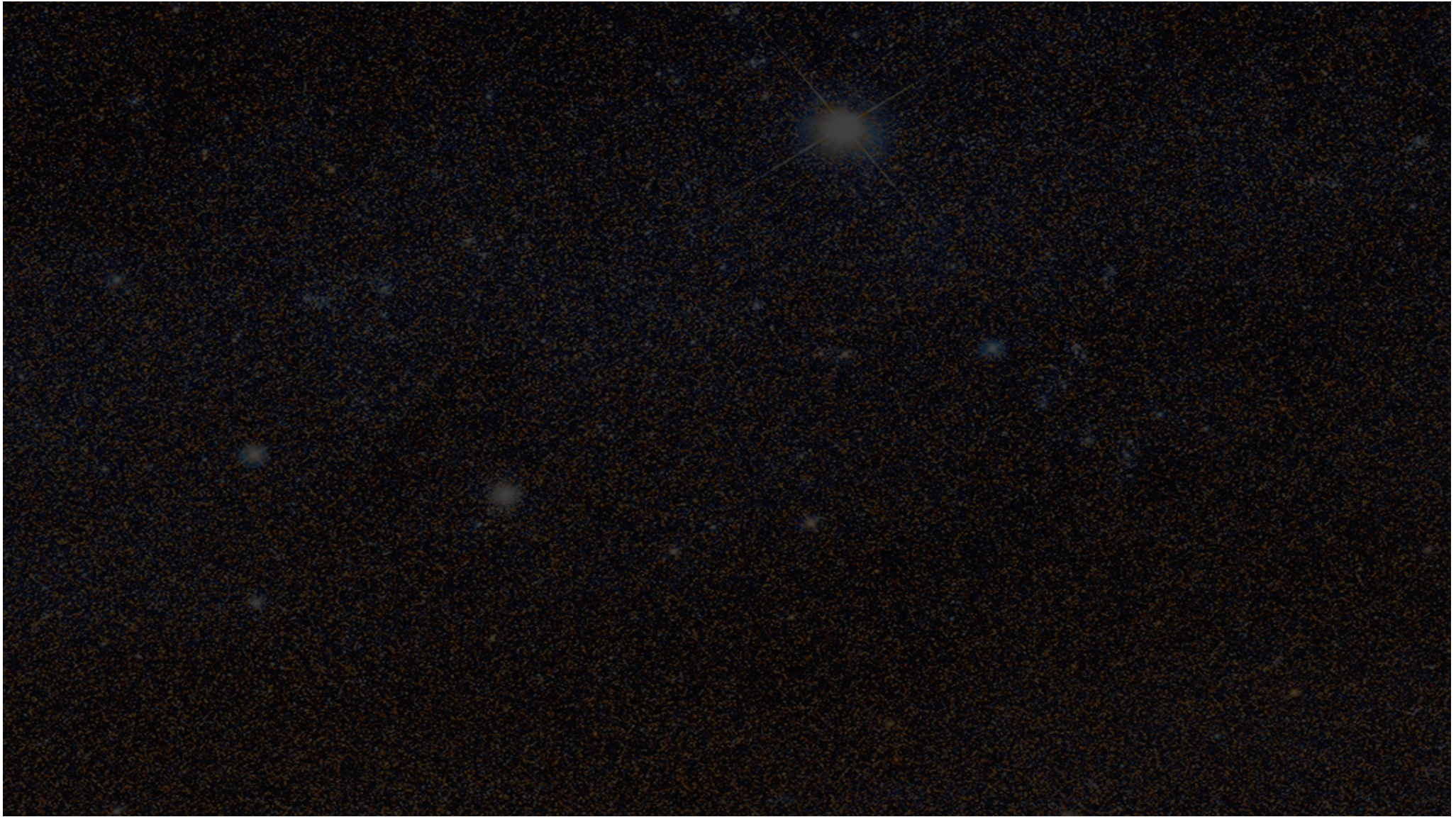






W F I R S T

Wide-Field Infrared Survey Telescope



“When you’re surrounded by people who share a collective passion around a common purpose, anything is possible.”
- Howard Schultz



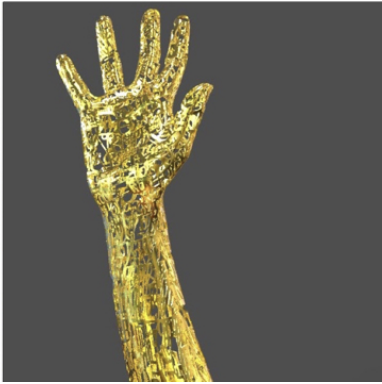
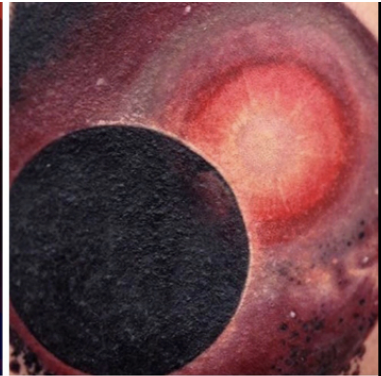
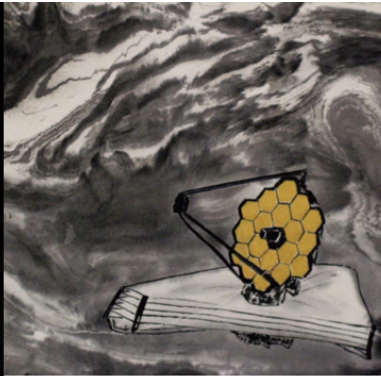
jwst.nasa.gov

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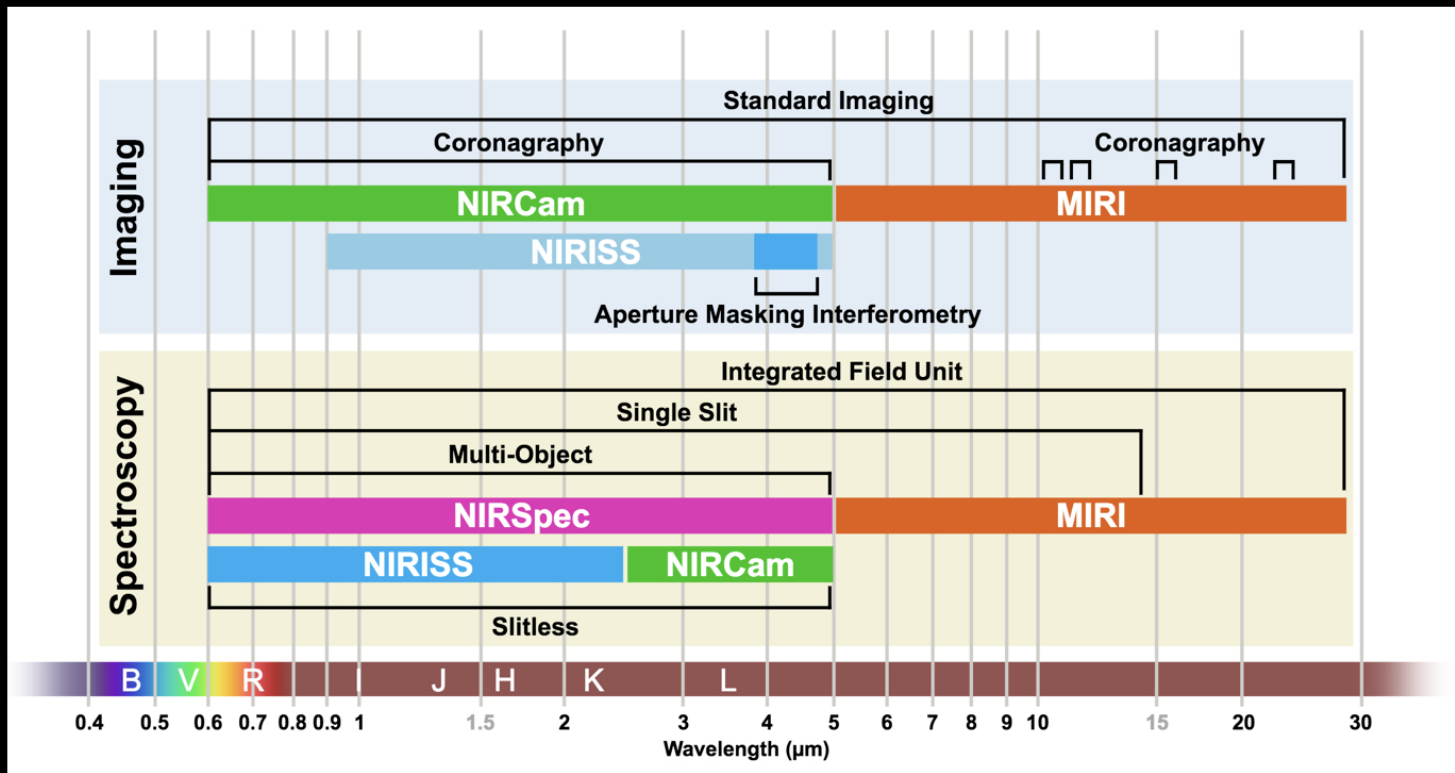


This is your telescope, too.

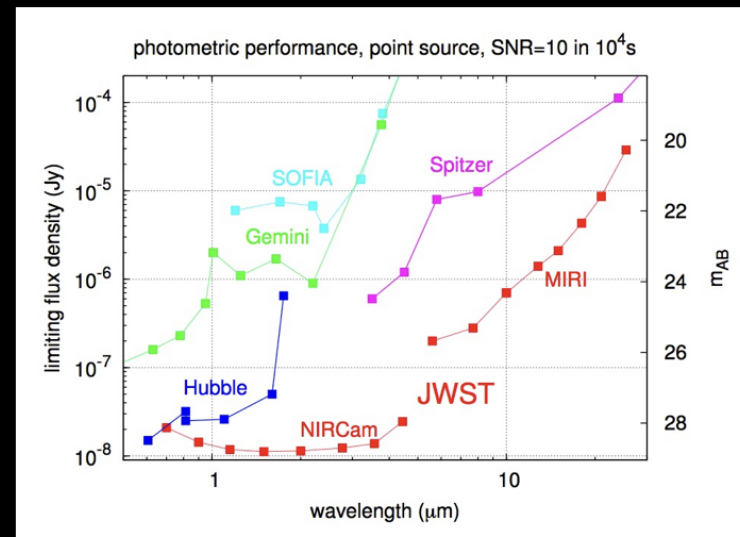
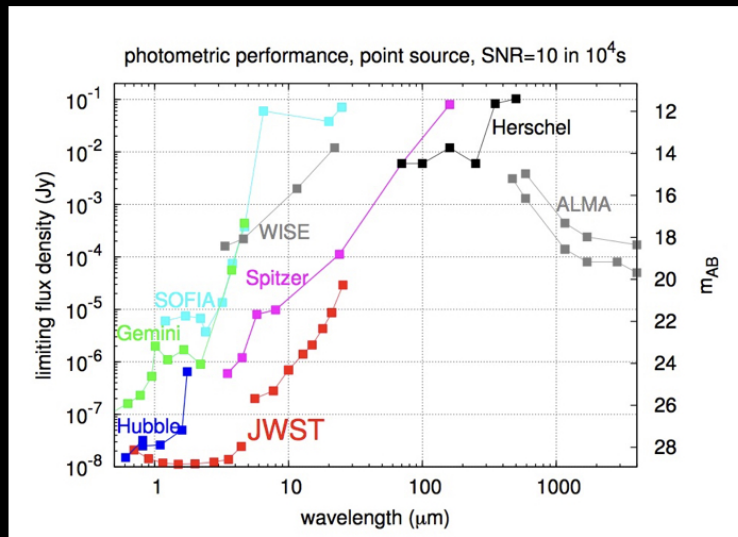
[jwst.nasa.gov](https://www.jwst.nasa.gov)



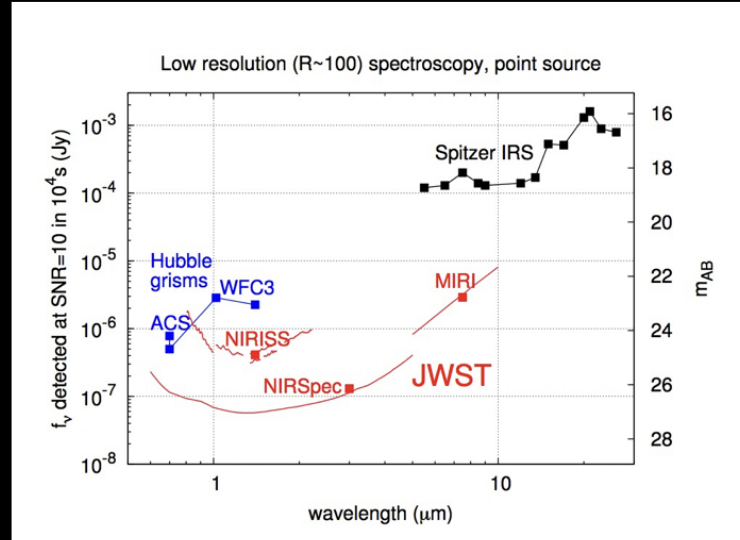
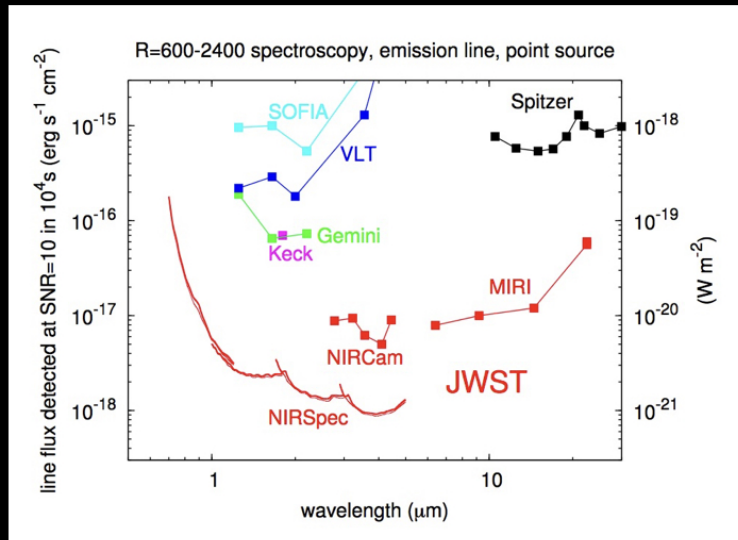
Instrumentation



JWST Sensitivity

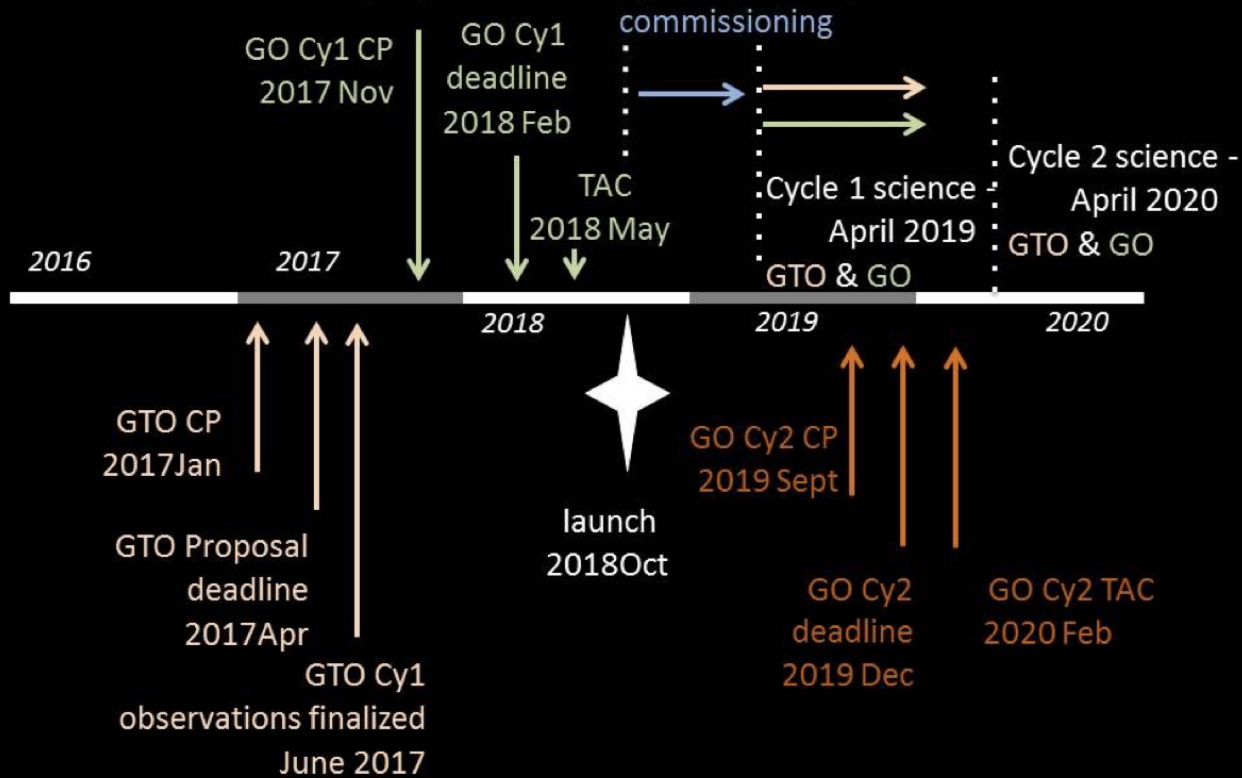


JWST Sensitivity

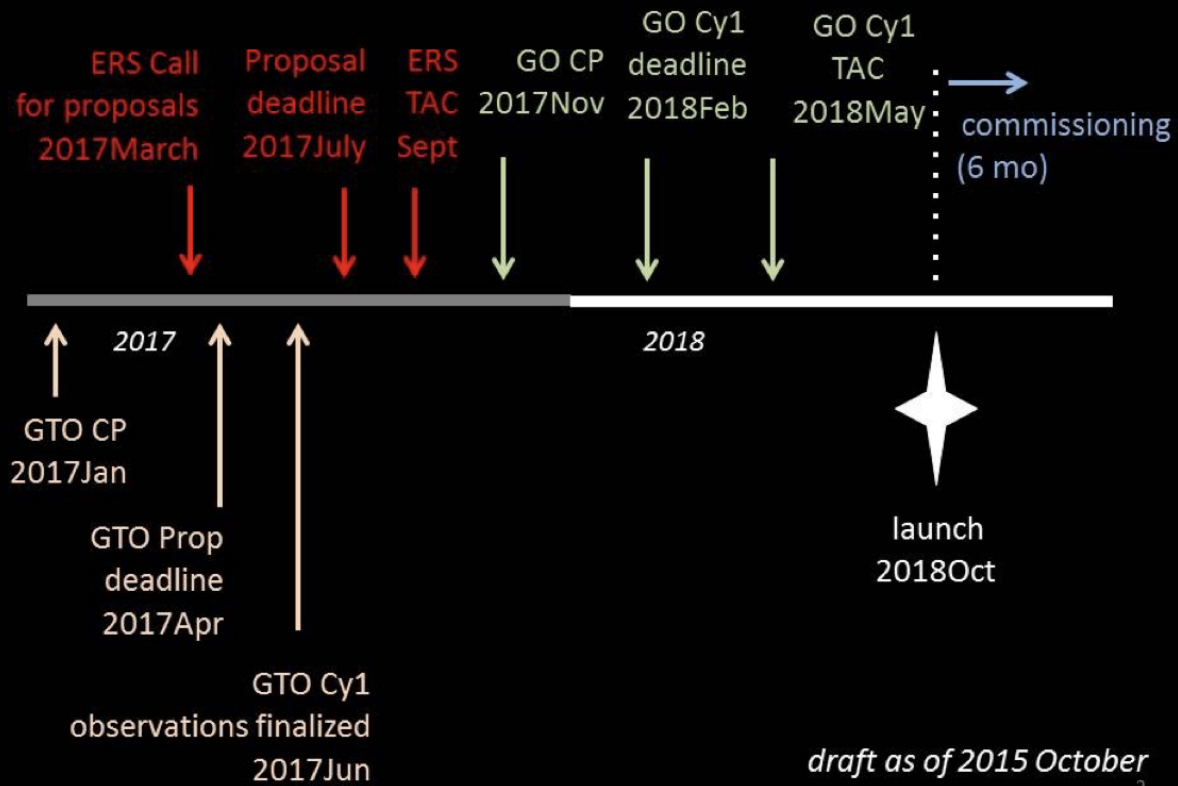


JWST Science Planning Timeline

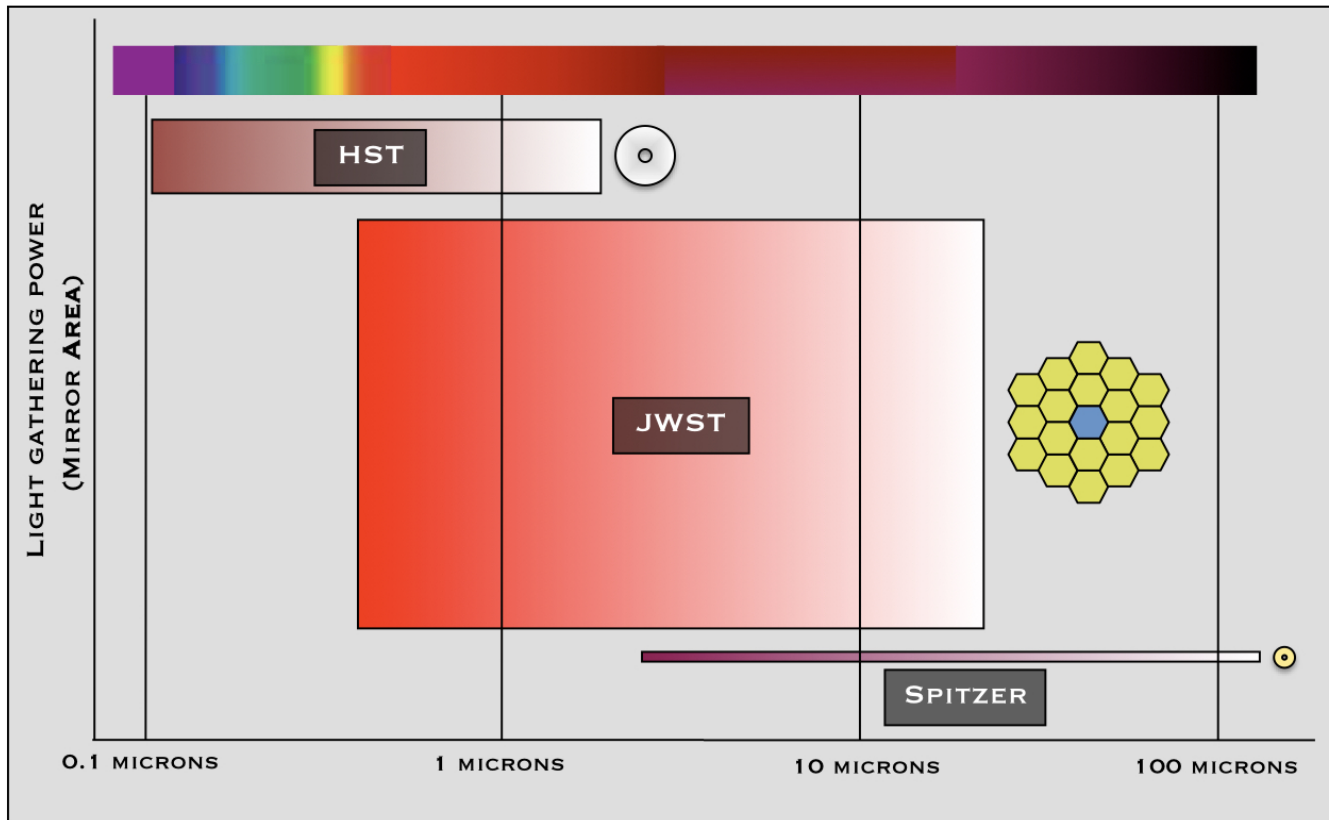
(draft schedule as of October 2015)



JWST Cycle 1 ERS Proposal Schedule



The James Webb Space Telescope



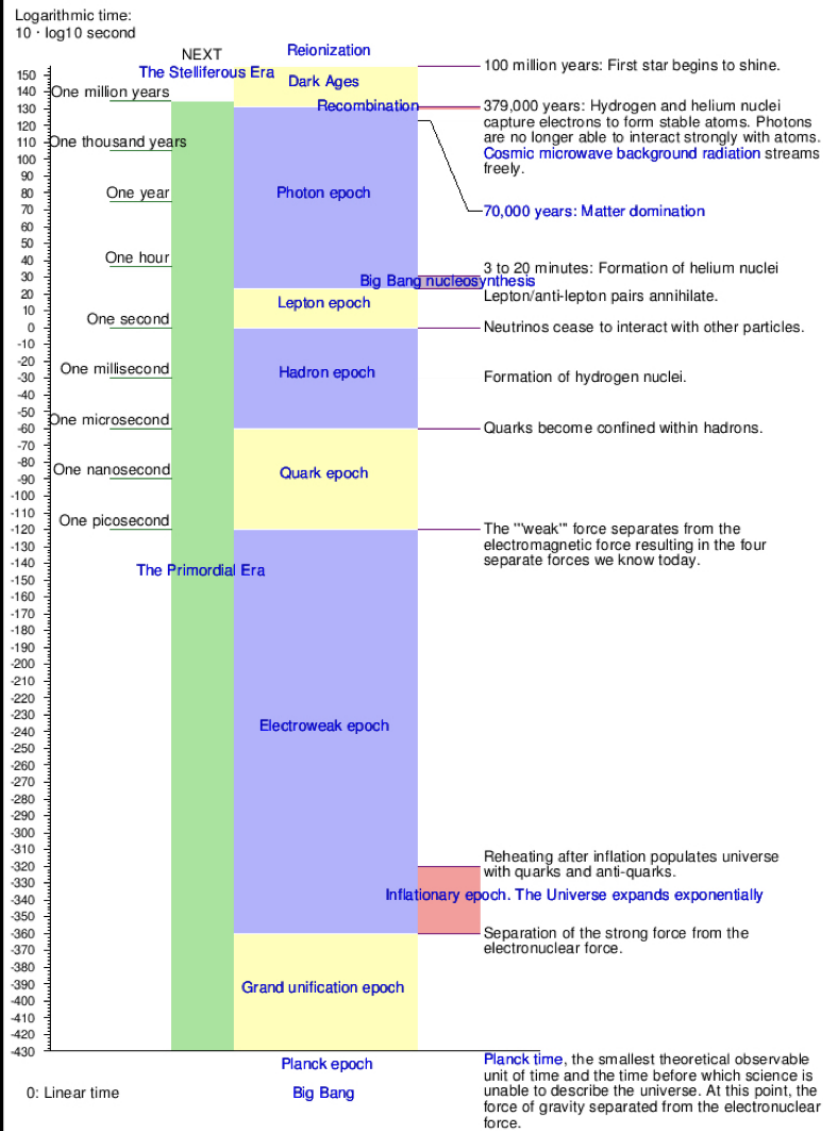
Light Gathering Power
JWST = 25 m²; Hubble = 4.5 m²; Spitzer = 0.6 m²

JWST Imaging Modes

Mode	Instrument	Wavelength (microns)	Pixel Scale (arcsec)	Field of View
Imaging	NIRCam	0.6 – 2.3	0.032	2.2 x 4.4'
	NIRCam	2.4 – 5.0	0.065	2.2 x 4.4'
	NIRISS	0.9 – 5.0	0.065	2.2 x 2.2'
	MIRI	5.0 – 28	0.11	1.23 x 1.88'
Aperture Mask Interferometry	NIRISS	3.8 – 4.8	0.065	2.2 x 2.2'
Coronagraphy	NIRCam	0.6 – 2.3	0.032	20 x 20"
	NIRCam	2.4 – 5.0	0.065	20 x 20"
	MIRI	10.65	0.11	24 x 24"
	MIRI	11.4	0.11	24 x 24"
	MIRI	15.5	0.11	24 x 24"
	MIRI	23	0.11	30 x 30"

JWST Spectroscopy Modes

Mode	Instrument	Wavelength (microns)	Resolving Power ($\lambda/\Delta\lambda$)	Field of View
Slitless Spectroscopy	NIRISS	1.0 – 2.5	150	2.2 x 2.2'
	NIRISS	0.6 – 2.5	700	single object
	NIRCam	2.4 – 5.0	2000	2.2 x 2.2'
Multi-Object Spectroscopy	NIRSpec	0.6 – 5.0	100, 1000, 2700	3.4 x 3.4' with 250k 0.2 x 0.5" microshutters
Single Slit Spectroscopy	NIRSpec	0.6 – 5.0	100, 1000, 2700	slits with 0.4 x 3.8" 0.2 x 3.3" 1.6 x 1.6"
	MIRI	5.0 – ~14.0	~100 at 7.5 microns	0.6 x 5.5" slit
IFU Spectroscopy	NIRSpec	0.6 – 5.0	100, 1000, 2700	3.0 x 3.0"
	MIRI	5.0 – 7.7	3500	3.0 x 3.9"
	MIRI	7.7 – 11.9	2800	3.5 x 4.4"
	MIRI	11.9 – 18.3	2700	5.2 x 6.2"
	MIRI	18.3 – 28.8	2200	6.7 x 7.7"





Near-Infrared Spectrograph

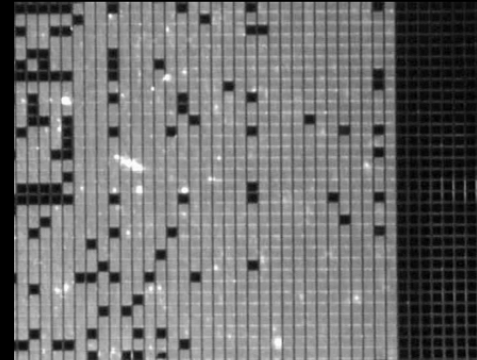


ESA instrument



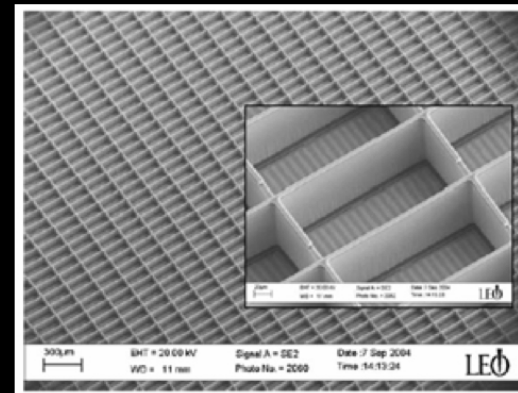
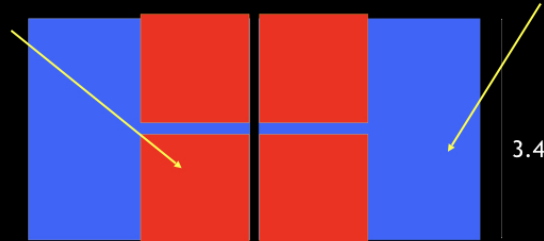
GSFC providing micro-shutters and detectors (H2RG)

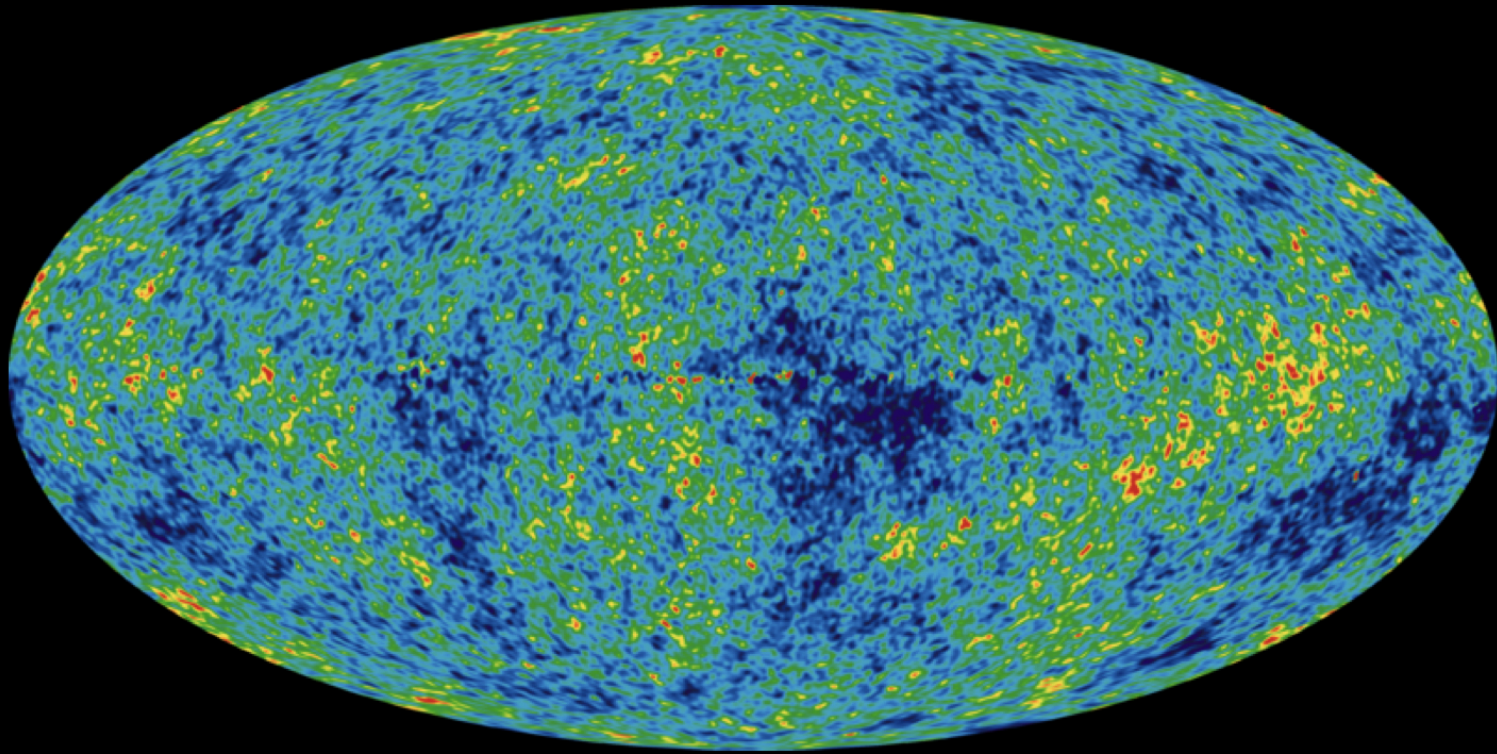
- Multi-Object Spectroscopy
 - Micro-shutter array
 - 3.4' x 3.4' FOV.
- R=1000 Mode
 - 3 gratings cover $1.0 < \lambda < 5.0 \mu\text{m}$
- R=100 Prism
 - $0.6 < \lambda < 5.0 \mu\text{m}$

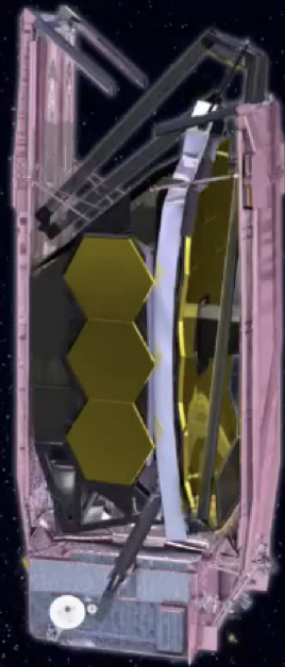


Micro-Shutters:
730 x 342 array of
203 x 463 mas pixels

Detectors:
2K x 4K array

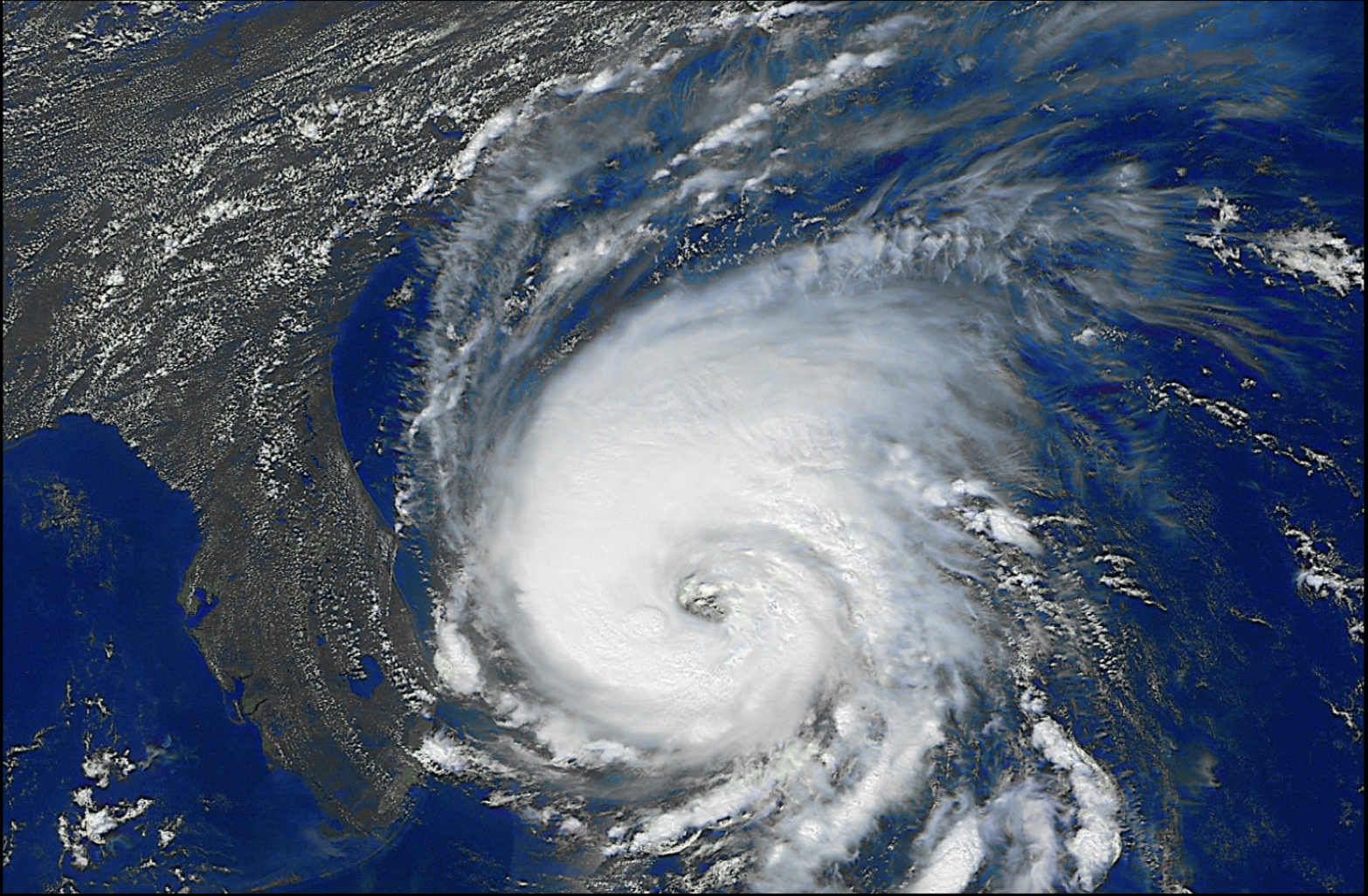




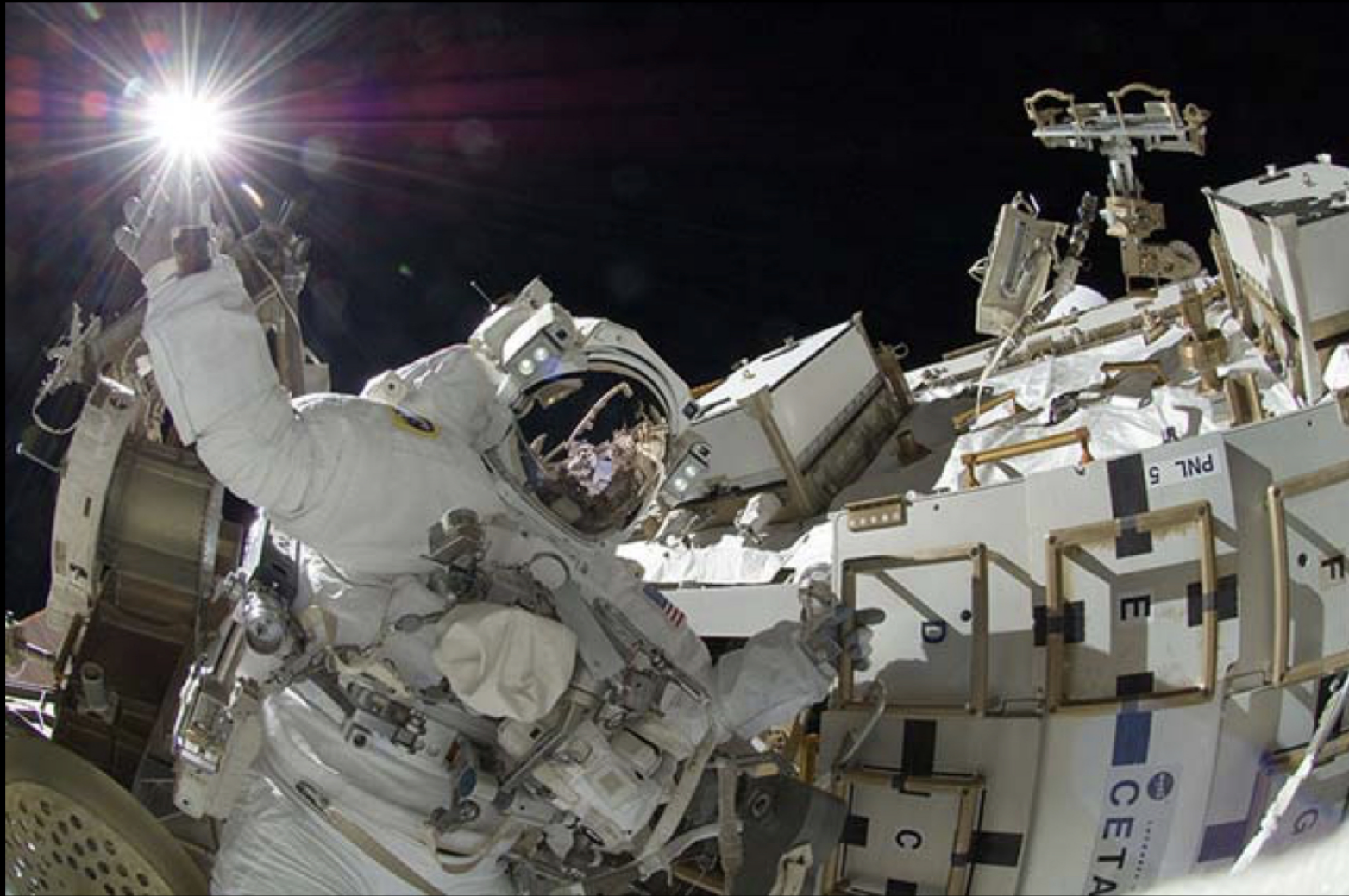


#JWST









Leading the World With a Balanced Program of Space Exploration, Aeronautics and Science Research



