Earth & Space Project-Based Professional Learning Community

NISE NATIONAL INFORMAL STEM EDUCATION NETWORK

EXPLORE SCIENCE Earth & Space

James Webb Space Telescope

Christine Chen, PhD
Space Telescope Science Institute

Recorded in April 2022 as part of the Earth & Space Project-Based Professional Learning Community Convening

Plenary Keynote

James Webb Space Telescope

Christine Chen, PhD

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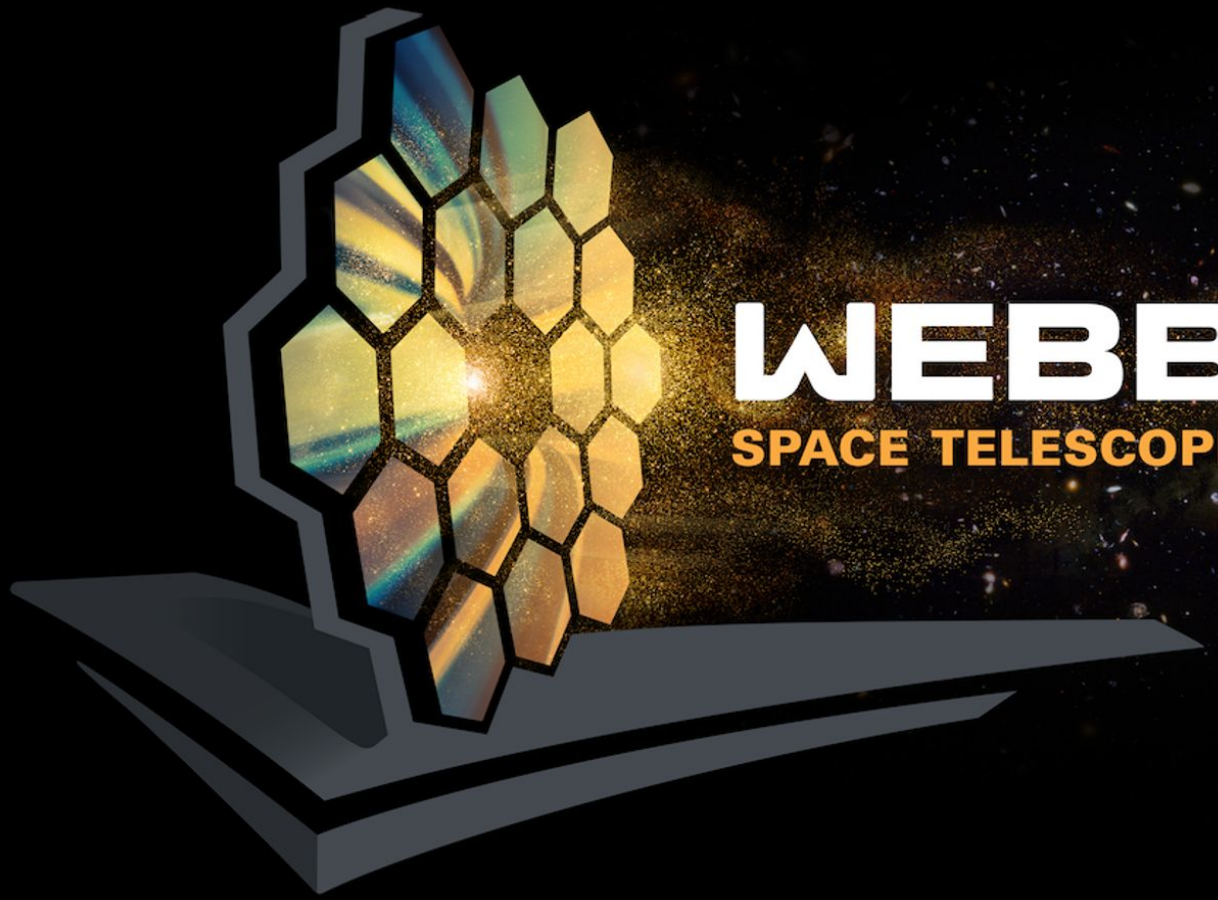


WEBB
SPACE TELESCOPE

NASA esa CSA ASC

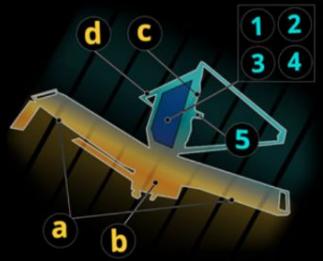
STScI | SPACE TELESCOPE SCIENCE INSTITUTE


WEBB
SPACE TELESCOPE

JAMES WEBB SPACE TELESCOPE
GODDARD SPACE FLIGHT CENTER

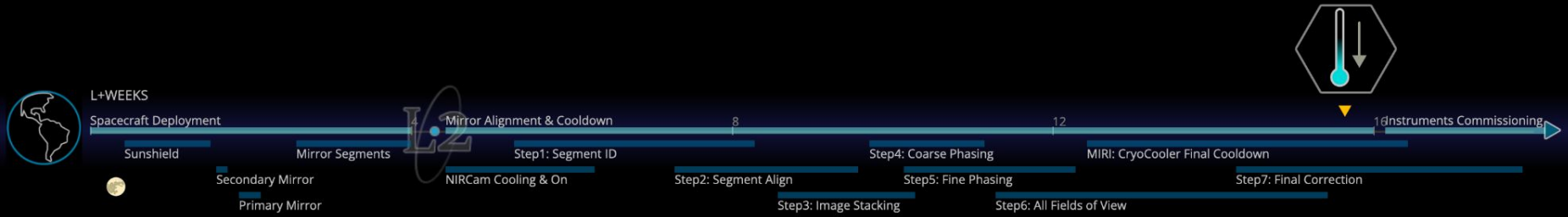
WHERE IS WEBB? | About This Page | English <> Metric

https://webb.nasa.gov/content/webbLaunch/whereIsWebb.html



Hot Side	Cold Side	MIRI / NIRCam / NirSpec	FGS-NIRISS / FSM
127F 326K (a)	-383F 42K (c)	-449F 06K (1)	-391F 38K (4)
56F 286K (b)	-394F 37K (d)	-391F 38K (2)	-402F 32K (5)
		-396F 35K (3)	

NEW! Temperature Plots | Plots Help | About Temps



TOP

Webb's Cool View on How Stars, Planets Form

Thaddeus Cesari

April 7, 2022

James Webb Space Telescope

The ongoing success of the multi-instrument optics alignment for NASA's Webb telescope's near-infrared instruments has moved the attention of the commissioning team to *chill* as we carefully monitor the cooling of the Mid-InfraRed Instrument (MIRI) down to its final operating temperature of less than 7 kelvins (-447 degrees Fahrenheit, or -266 degrees Celsius). We are continuing other activities during this slow cooldown which include monitoring the near-infrared instruments. As MIRI cools, other major components of the observatory, such as the backplane and mirrors, also continue to cool and are approaching their operational temperatures.

Last week, the Webb team did a station-keeping thruster burn to maintain Webb's position in orbit around the second Lagrange point. This was the second burn since Webb's arrival at its final orbit in January; these burns will continue periodically throughout the lifetime of the mission.

In the last few weeks, we have been sharing some of Webb's anticipated science.

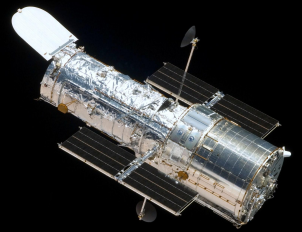
WEBB SPACE TELESCOPE

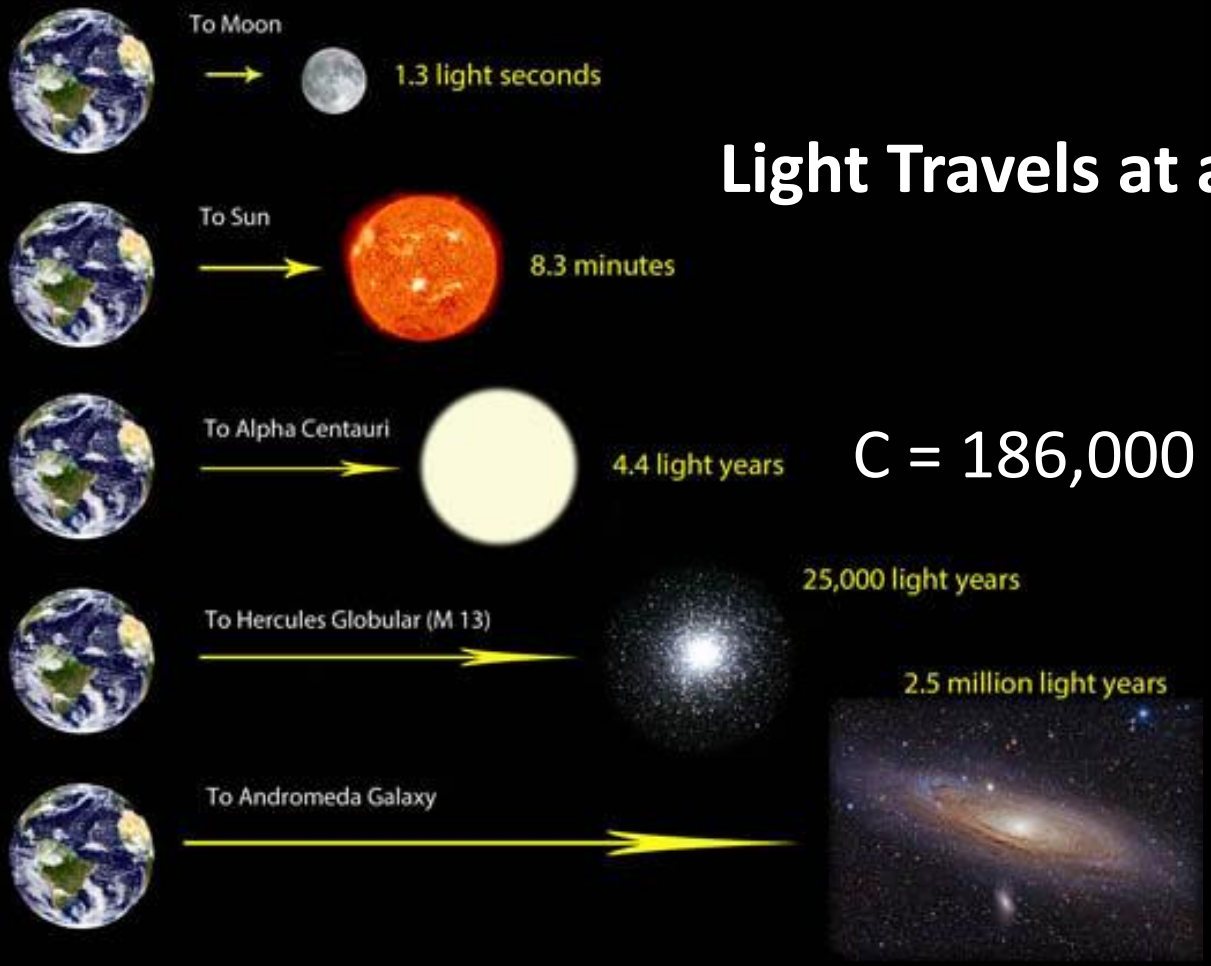
ABOUT THE WEBB TELESCOPE

The James Webb Space Telescope is the world's largest, most powerful, and most complex space science telescope ever built. Webb will solve mysteries in our solar system, look beyond to distant worlds around other stars, and probe the mysterious structures and origins of our universe and our place in it. Webb is an international program led by NASA with its partners, ESA (European Space Agency) and

Hubble Deep Field 1995

Hubble Deep Field 1995





Light Travels at a Fixed Speed

C = 186,000 miles per second

Hubble Probes the Early Universe

1990
Ground-based observatories

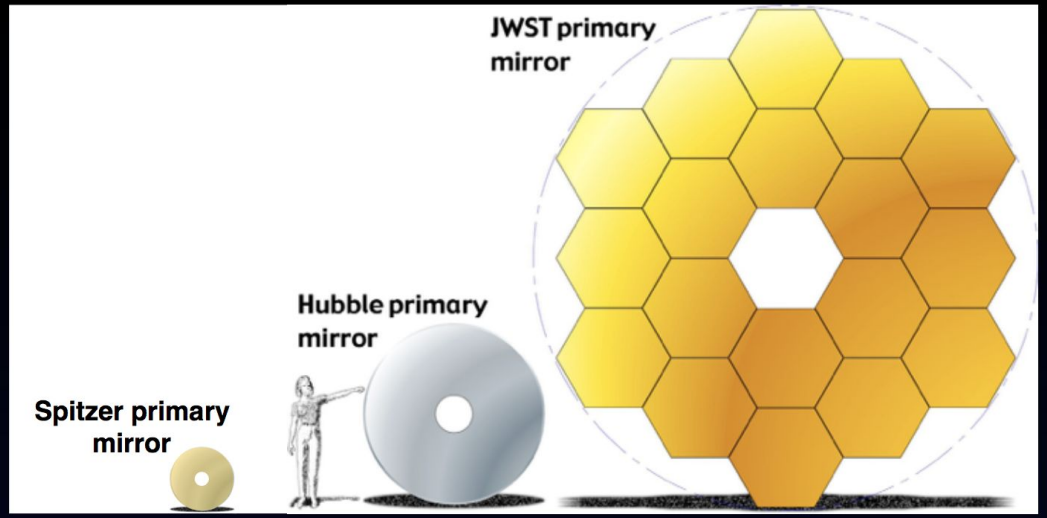
1995
Hubble Deep Field

2004
Hubble Ultra Deep Field

2010
Hubble Ultra Deep Field-IR

FUTURE
James Webb Space Telescope

Redshift (*z*):	Present	1	4	5	6	7	8	10	>20
Time after the Big Bang		6 billion years	1.5 billion years			800 million years		480 million years	200 million years



	Hubble	Spitzer	JWST
Primary diameter	2.4	0.85	6.6
Collecting Area (m	4.24	0.5	26.3
Observatory Mass (kg)	11,000	860	6,300
Observatory Volume, when stowed (m	190	13	155
Orbit Location	LEO	Earth-trailing solar	Sun-Earth L2

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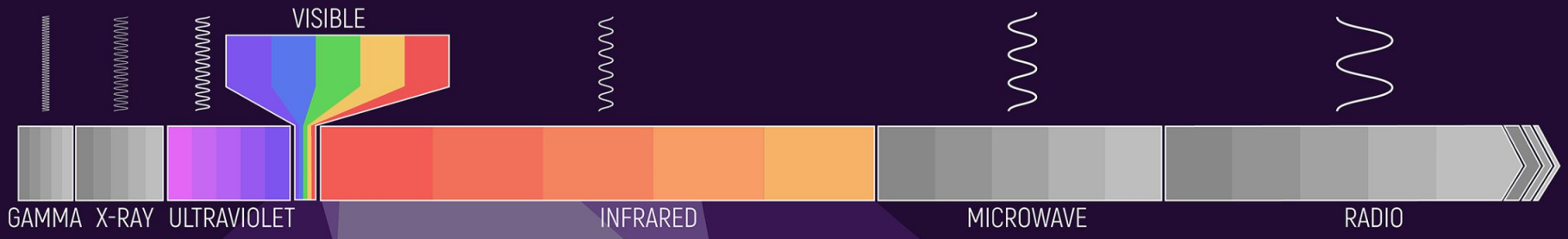
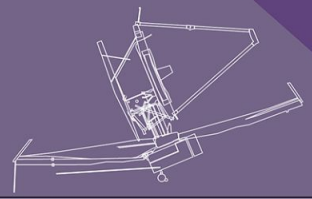
ELECTROMAGNETIC SPECTRUM



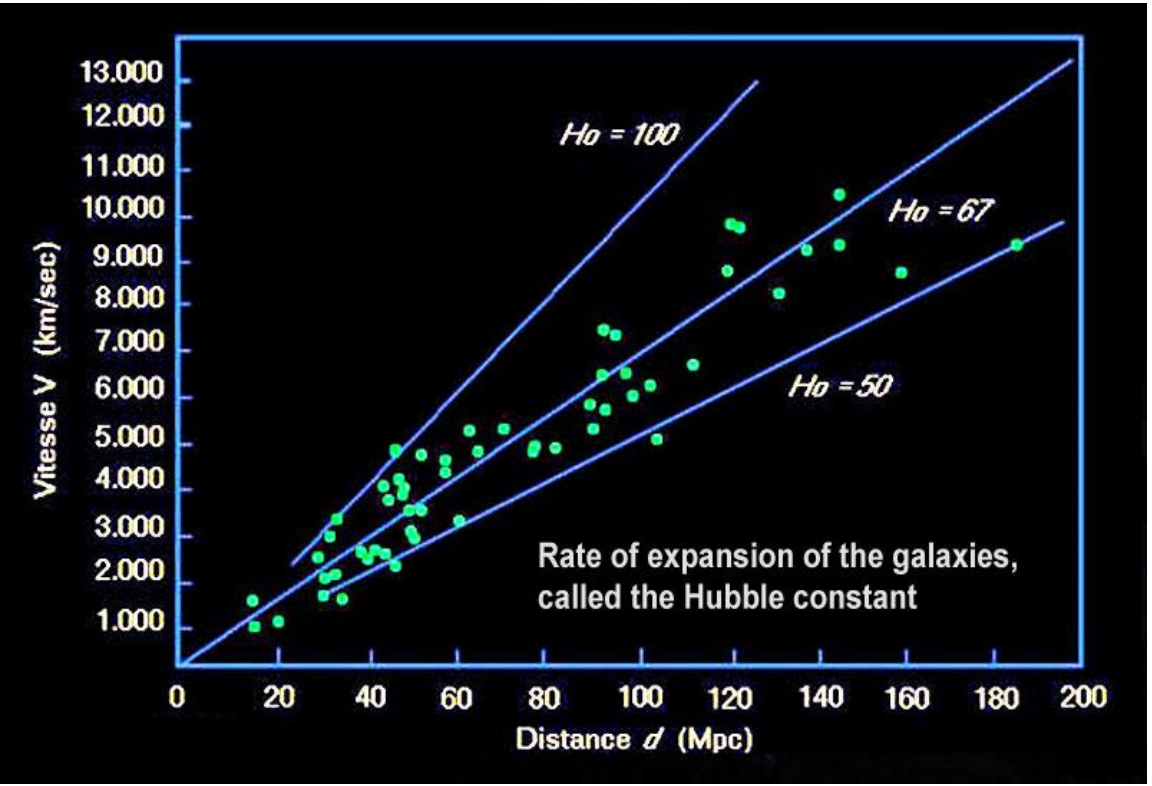
HUBBLE SPACE TELESCOPE
90-2,500 NM



JAMES WEBB SPACE TELESCOPE
600-28,500 NM

SPITZER SPACE TELESCOPE
3,000-160,000 NM

The Universe is Expanding



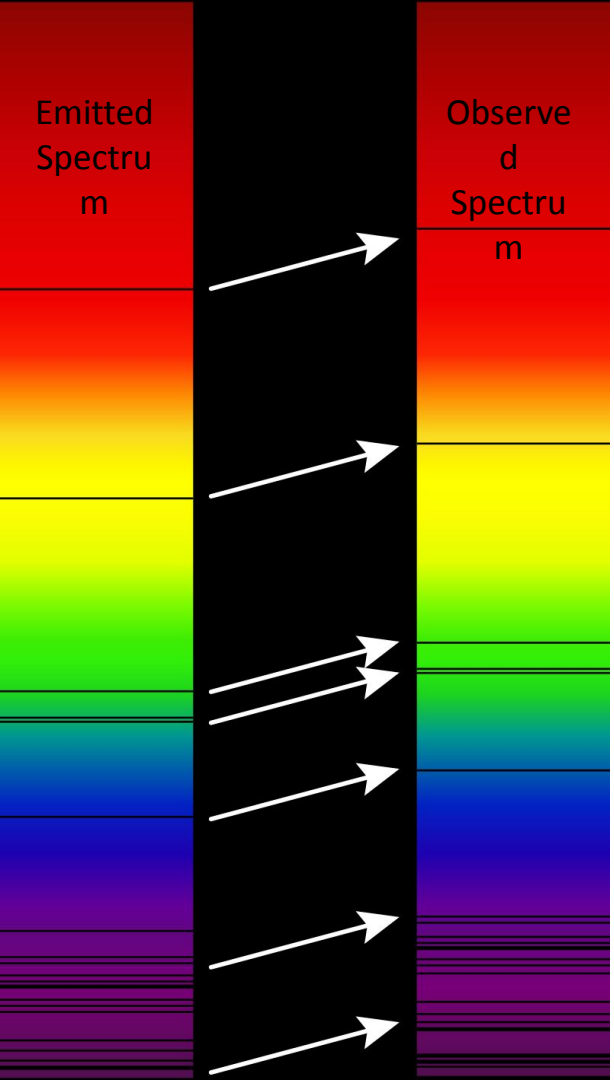
- Hubble's Law

$$v = H_o r$$

v = velocity of galaxies moving away from us

r = distances to those galaxies

H_o = Hubble's constant or the rate of expansion of the galaxies



Redshift

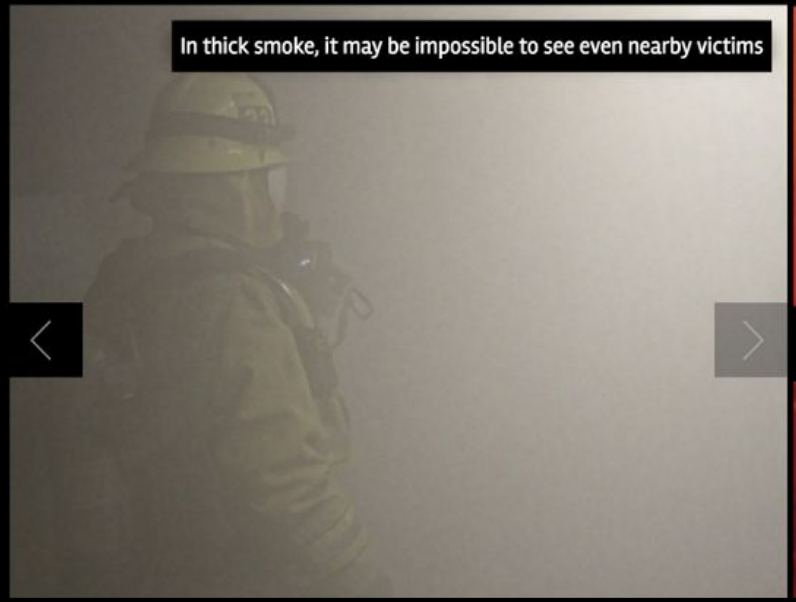
- The Doppler effect is the change in wavelength of a wave compared to an observer who is moving relative to the source

$$z = \frac{\lambda_{obsv} - \lambda_{emit}}{\lambda_{emit}}$$

z = redshift

λ_{obs} = observed wavelength

λ_{emit} = emitted wavelength


In thick smoke, it may be impossible to see even nearby victims


In thick smoke, it may be impossible to see even nearby victims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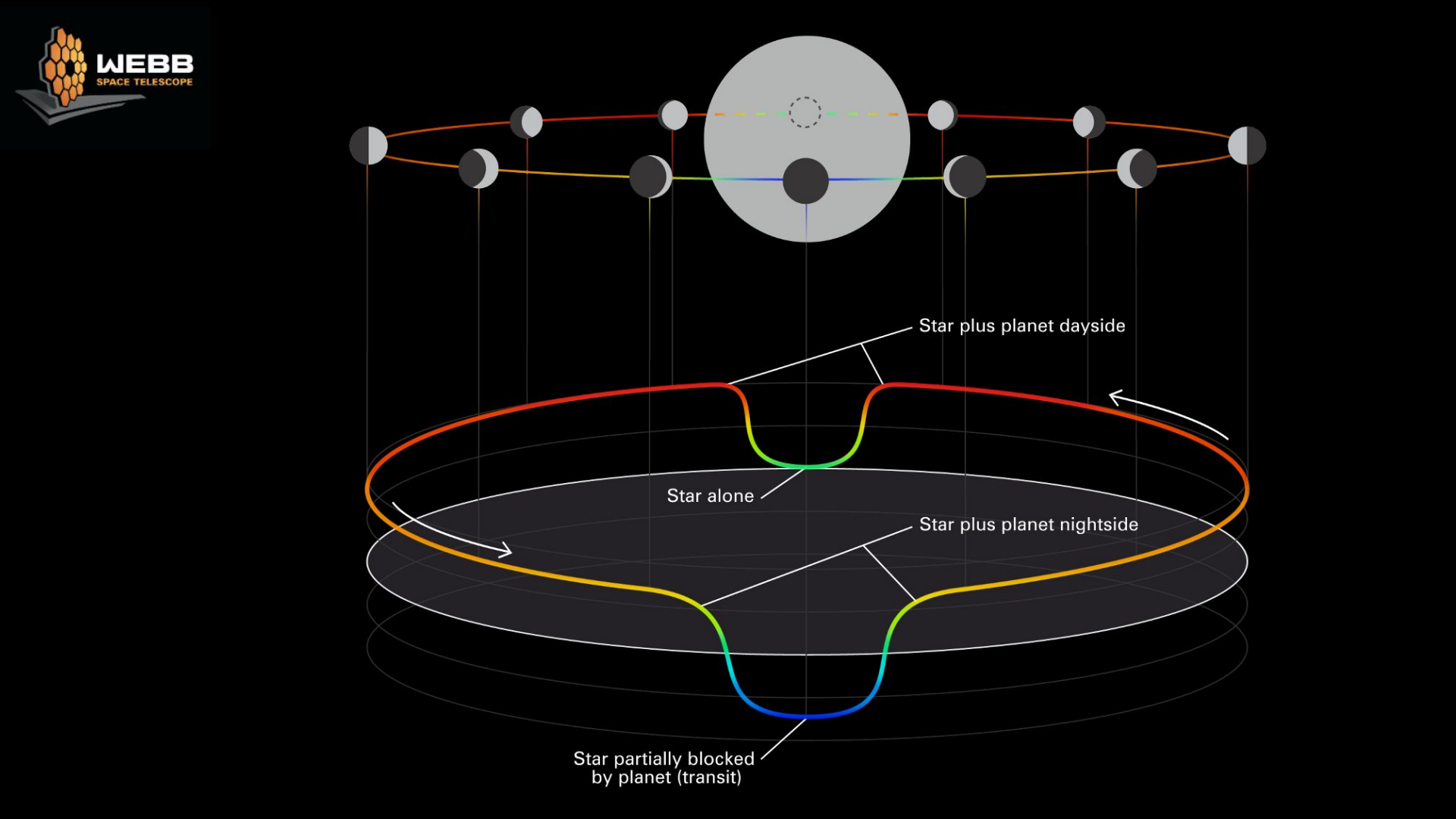
SPACE TELESCOPE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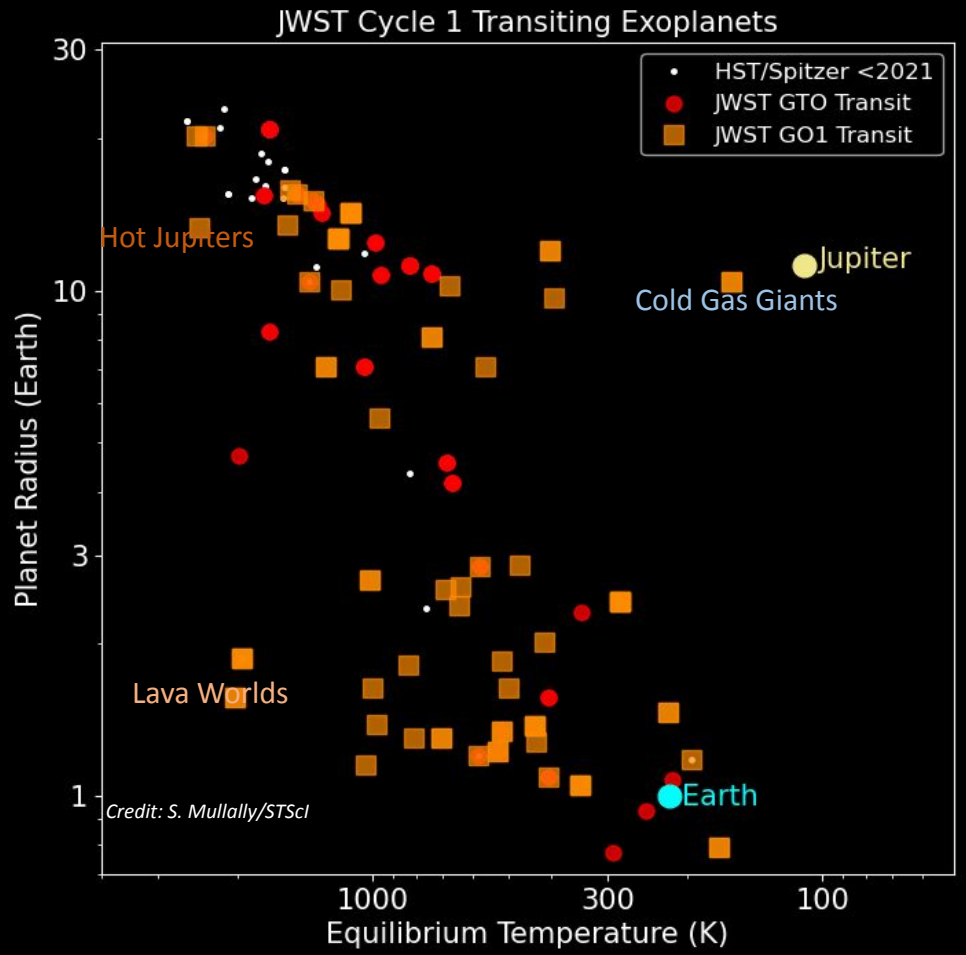
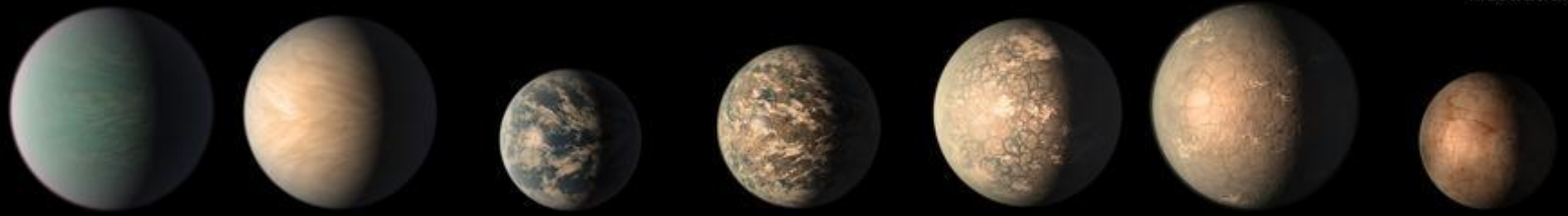
Star plus planet dayside
Star alone
Star plus planet nightside
Star partially blocked
by planet (transit)

Study Exoplanets

In its first year, JWST will

- Explore the diversity of exoplanet atmospheres across a range of size, temperature, age and host star environment.
- Hot Jupiters are gas giant planets orbiting close to their host star (<0.1 au) so that one orbit takes < 10 days
- Mini Neptunes are small gas giant planets
- Super Earths are rocky planets larger than Earth





TRAPPIST-1 System

Feb. 2018

	b	c	d	e	f	g	h
Orbital Period	1.51 *days*	2.42 *days*	4.05 *days*	6.10 *days*	9.21 *days*	12.36 *days*	18.76 *days*
Distance to Star	0.0115 *AU*	0.0158 *AU*	0.0223 *AU*	0.0293 *AU*	0.0385 *AU*	0.0469 *AU*	0.0619 *AU*
Planet Radius	1.12 R_{earth}	1.10 R_{earth}	0.78 R_{earth}	0.91 R_{earth}	1.05 R_{earth}	1.15 R_{earth}	0.77 R_{earth}
Planet Mass	1.02 M_{earth}	1.16 M_{earth}	0.30 M_{earth}	0.77 M_{earth}	0.93 M_{earth}	1.15 M_{earth}	0.33 M_{earth}
Planet Density	0.73 ρ_{earth}	0.88 ρ_{earth}	0.62 ρ_{earth}	1.02 ρ_{earth}	0.82 ρ_{earth}	0.76 ρ_{earth}	0.72 ρ_{earth}
Surface Gravity	0.81 *g*	0.96 *g*	0.48 *g*	0.93 *g*	0.85 *g*	0.87 *g*	0.55 *g*

Solar System

Rocky Planets

	Mercury	Venus	Earth	Mars
Orbital Period	87.97 *days*	224.70 *days*	365.26 *days*	686.98 *days*
Distance to Star	0.387 *AU*	0.723 *AU*	1.000 *AU*	1.524 *AU*
Planet Radius	0.38 R_{earth}	0.95 R_{earth}	1.00 R_{earth}	0.53 R_{earth}
Planet Mass	0.06 M_{earth}	0.82 M_{earth}	1.00 M_{earth}	0.11 M_{earth}
Planet Density	0.98 ρ_{earth}	0.95 ρ_{earth}	1.00 ρ_{earth}	0.71 ρ_{earth}
Surface Gravity	0.38 *g*	0.90 *g*	1.00 *g*	0.38 *g*


In July 2022,
NASA will reveal the JWST
Early Release Observations…
https://webbtelescope.org

Thank You

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This material is based upon work supported by NASA under cooperative agreement award numbers NNX16AC67A and 80NSSC18M0061. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the view of the National Aeronautics and Space Administration (NASA).