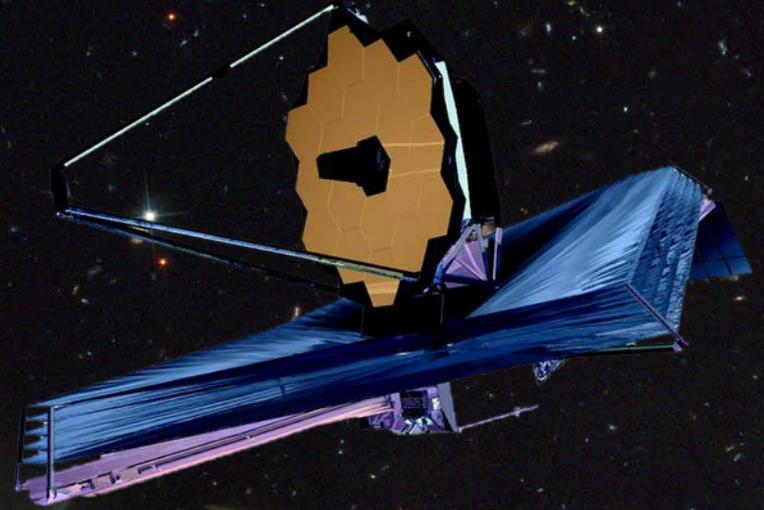


The James Webb Space Telescope



Jonathan P. Gardner

NASA's Goddard Space Flight Center

<http://jwst.nasa.gov>

Space Science Reviews, 2006, 123/4, 485

Agenda

Jonathan Gardner	Deputy Senior Project Scientist	Science
Amber Straughn	Deputy Project Scientist for Communications	Outreach
Mark Clampin	Observatory Project Scientist	Observatory Progress
Matt Greenhouse	ISIM Project Scientist	ISIM Progress



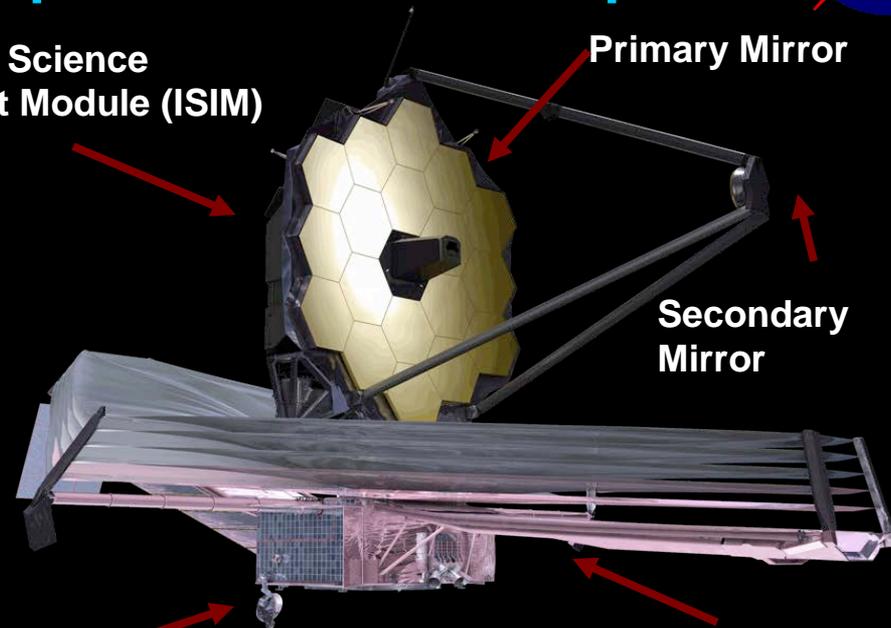
James Webb Space Telescope

- 6.6m Telescope
- Successor to Hubble & Spitzer.
- Demonstrator of deployed optics.
- 4 instruments: 0.6 to 28.5 μm
- Passively cooled to $< 50 \text{ K}$.
- Named for 2nd NASA Administrator
- Launch late 2018

Integrated Science Instrument Module (ISIM)

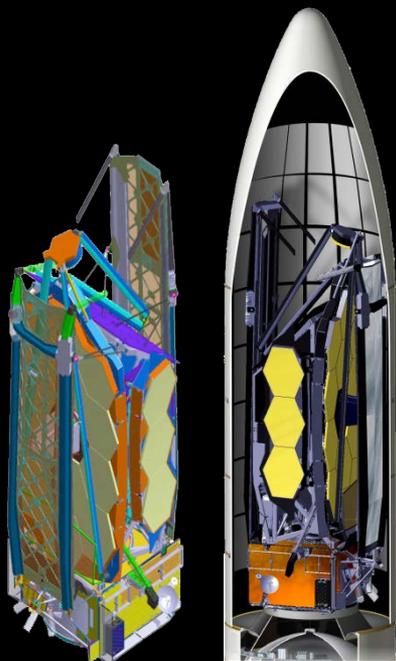
Primary Mirror

Secondary Mirror



5 Layer Sunshield

Spacecraft Bus



- Complementary to GMT, ALMA, WFIRST, etc
- NASA + ESA + CSA: 14 countries
- Lead: Goddard Space Flight Center
- Prime: Northrop Grumman
- Operations: STScI
- Senior Project Scientist:
Nobel Laureate John Mather

Science Personnel Changes

- HQ:



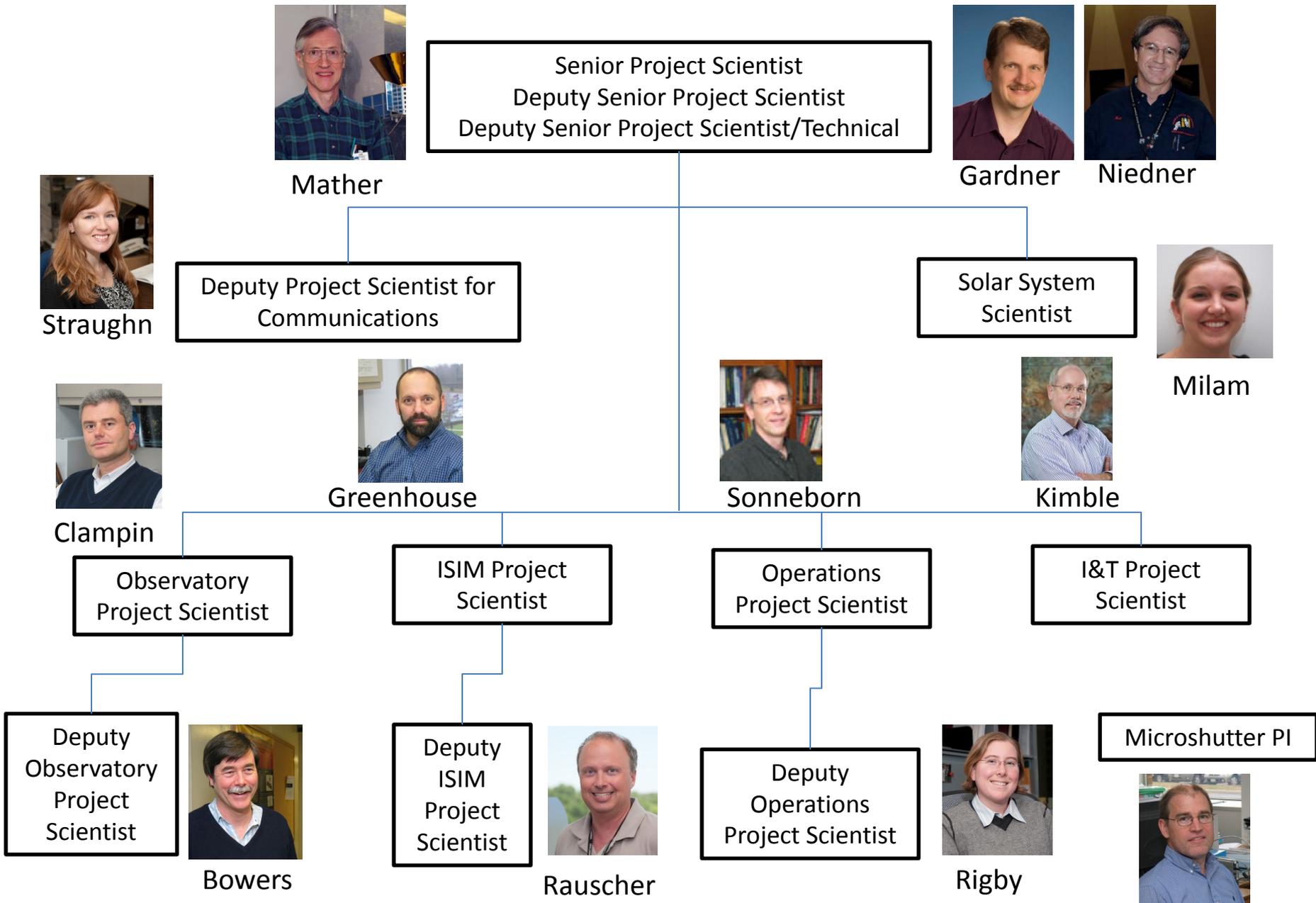
- Geoff Yoder left JWST to become SMD Deputy AA for Programs
- Eric Smith is Acting JWST Program Director
- Hashima Hasan continues as Deputy Program Scientist for JWST within the Astrophysics Division



- STScI

- Massimo Stiavelli is Head of JWST Mission Office
- Jason Kalirai is JWST Project Scientist at STScI
- Rachel Osten is JWST Deputy Project Scientist





JWST Project Science Team at Goddard

JWST Science Working Group



John Mather,
Senior Project Scientist,
Chair



Mark Clampin,
Observatory PS



Rene Doyon,
CSA PS



Pierre Ferruit,
ESA PS



Kathy Flanagan,
SOC



Marijn Franx,
NIRSpec Science



Jonathan Gardner,
Dep Sr PS



Matt Greenhouse,
ISIM PS



Heidi Hammel,
IDS



Simon Lilly,
IDS



Jonathan Lunine,
IDS



Mark McCaughrean,
IDS



Matt Mountain,
Telescope Scientist



Mal Niedner,
DSPS/Technical



George Rieke,
MIRI Science Lead



Marcia Rieke,
NIRCam PI



George Sonneborn,
Ops PS



Massimo Stiavelli,
IDS



Rogier Windhorst,
IDS



Chris Willott,
NIRISS Science

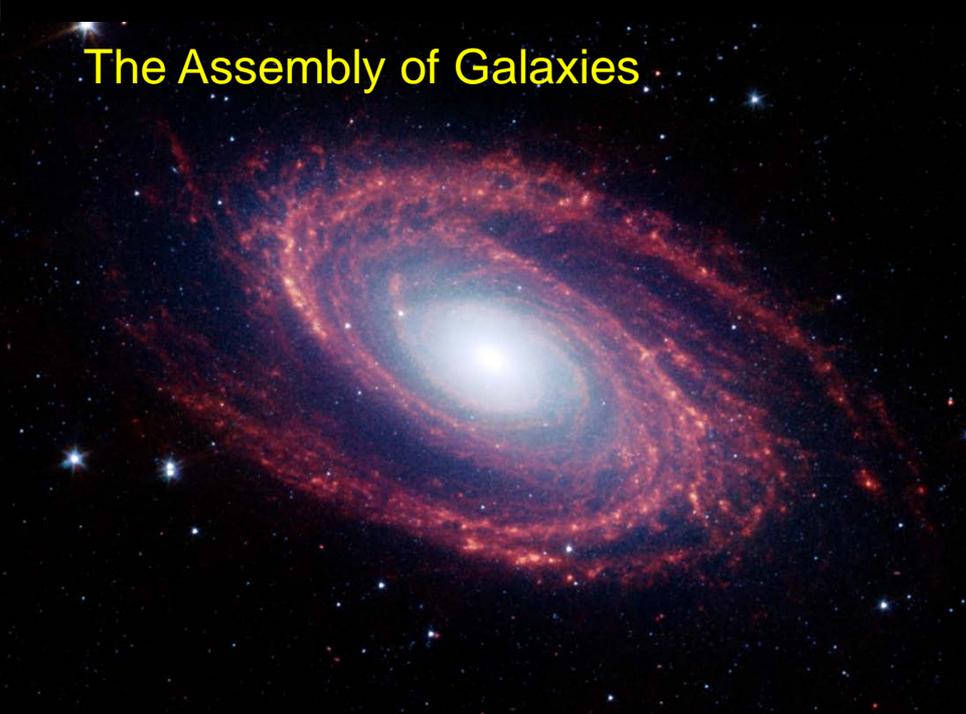


Gillian Wright,
MIRI European Lead

End of the Dark Ages: First Light and Reionization



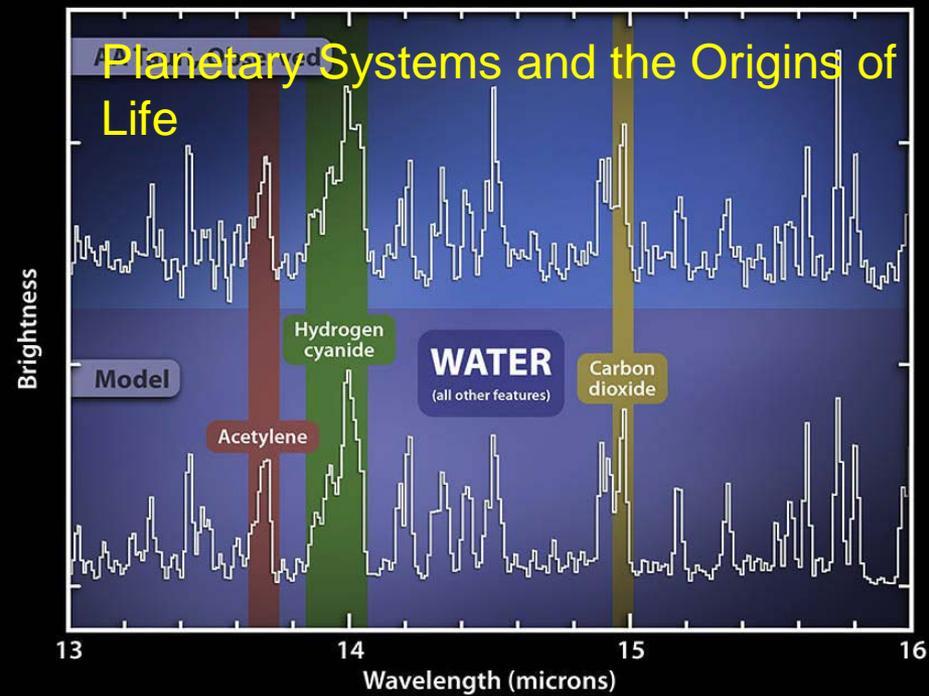
The Assembly of Galaxies



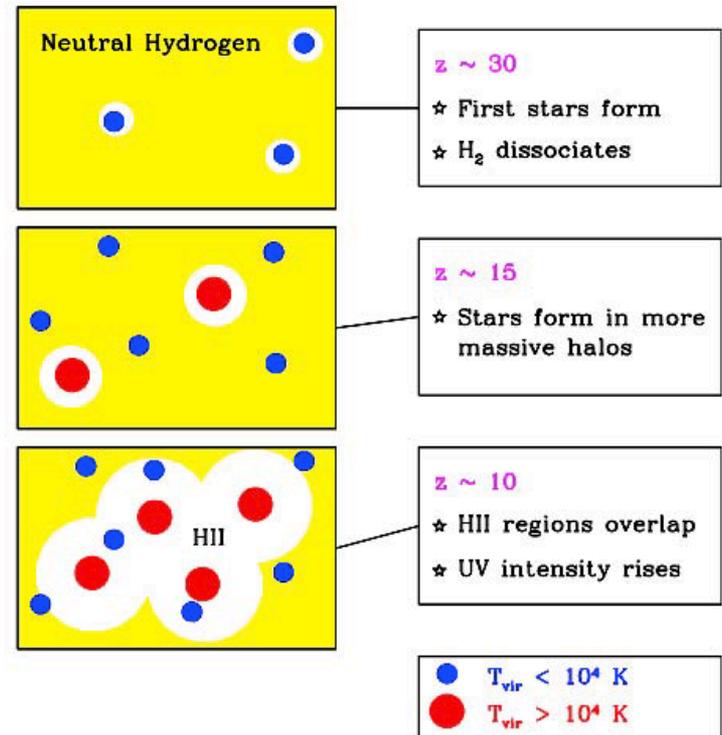
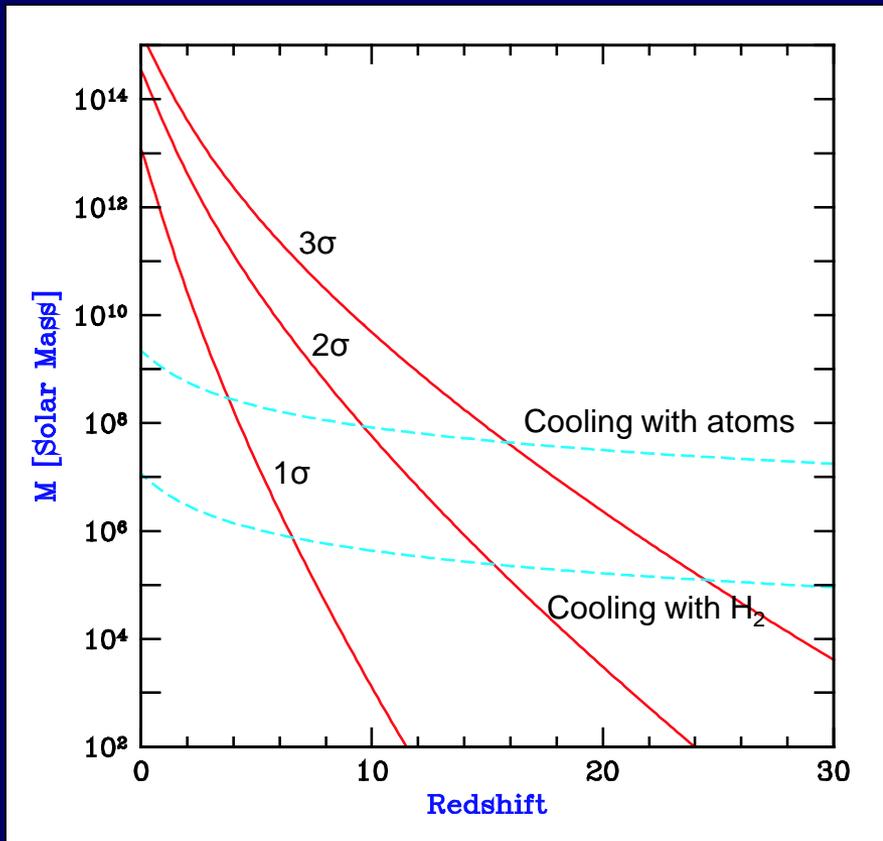
Birth of Stars and Protoplanetary Systems



Planetary Systems and the Origins of Life

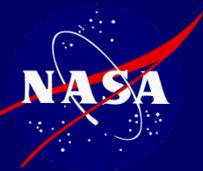


What are the first galaxies?



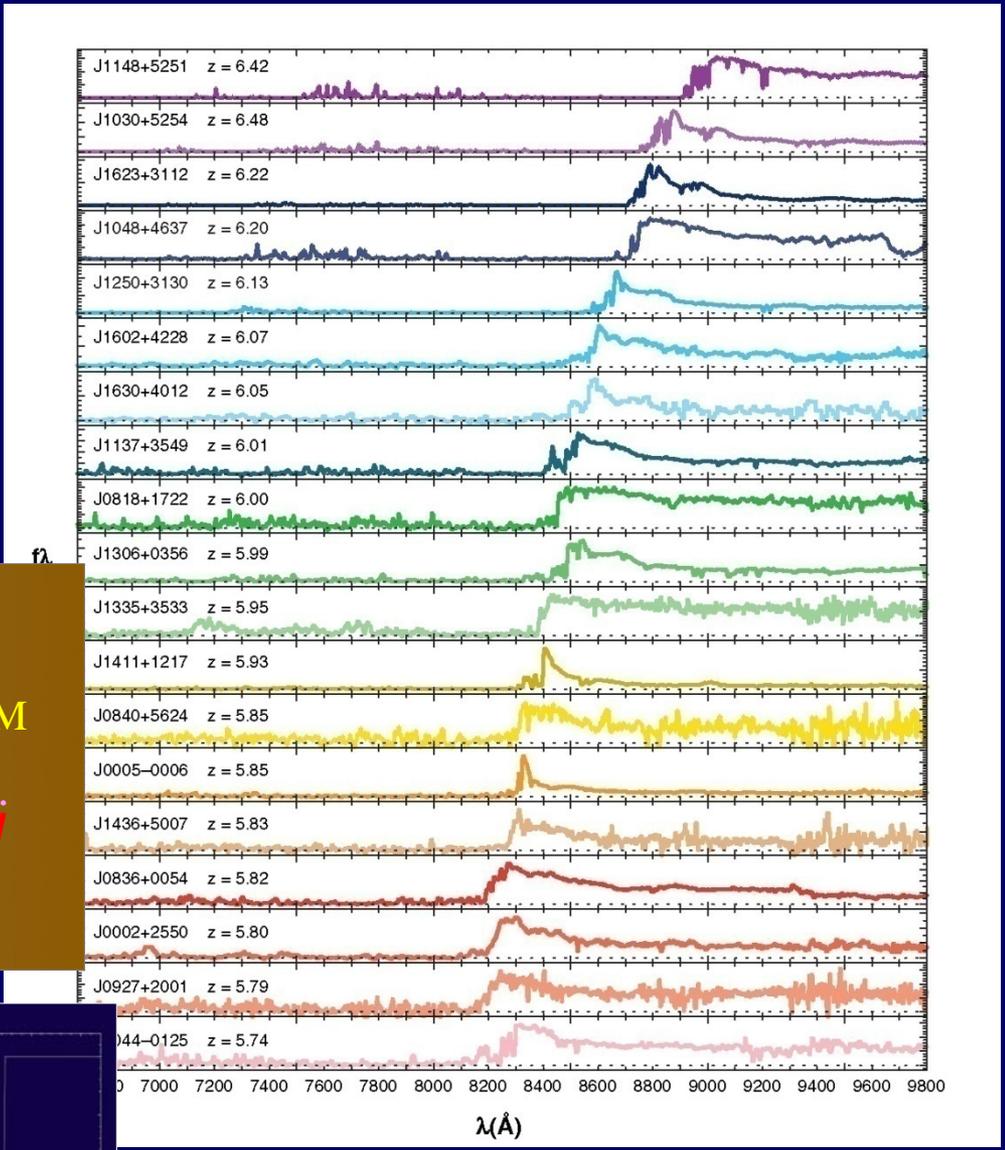
Barkana & Loeb 2001, Physics Reports, 349, 125

- Observations:
 - Ultra-deep NIR field, find $z > 15$ H-band dropouts, 1.4 nJy
 - Follow-up Spect, MIR
 - Timing for transients to find SNe

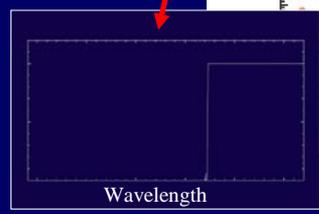
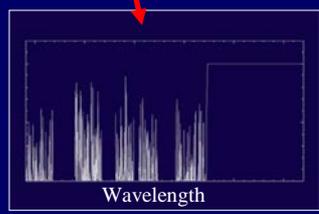
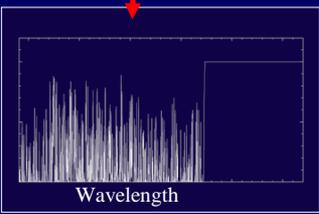
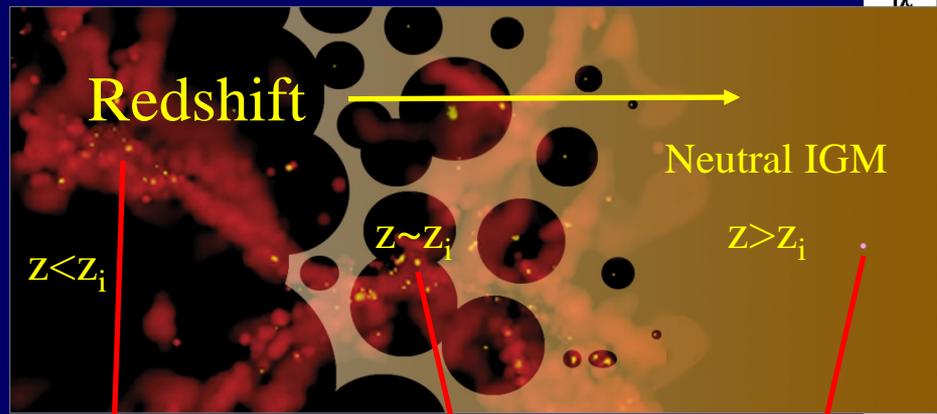


6.42

What was re-ionization?



6.00



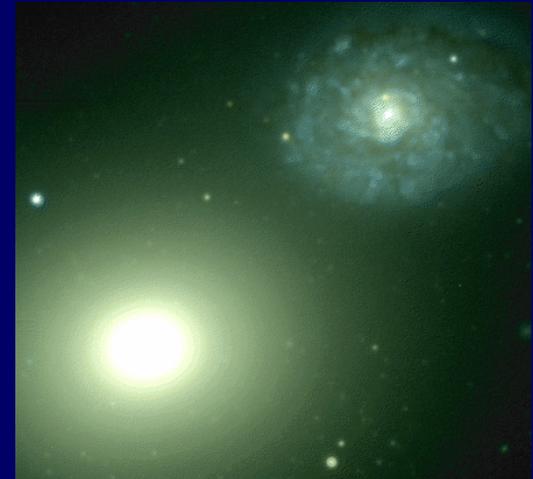
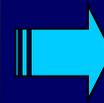
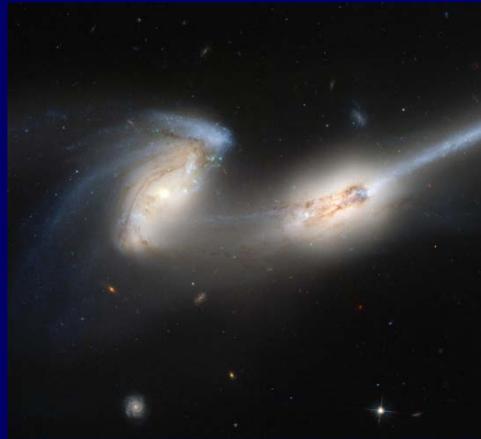
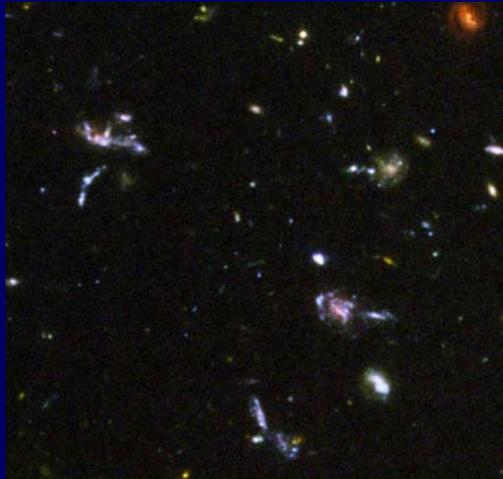
Lyman Forest Absorption

Patchy Absorption

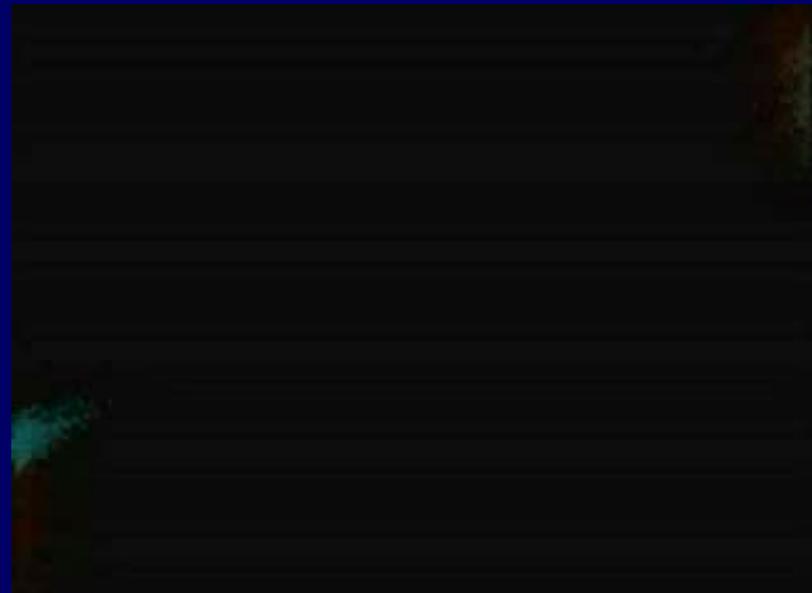
Black Gunn-Peterson trough

5.74

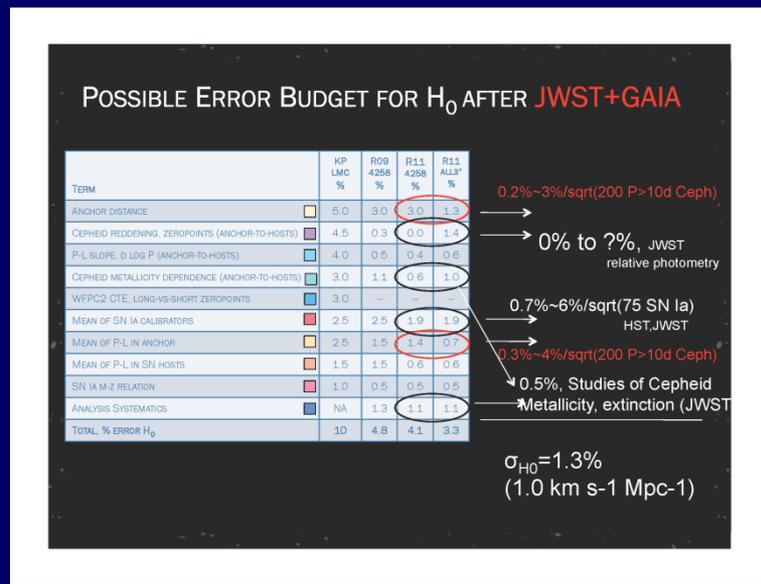
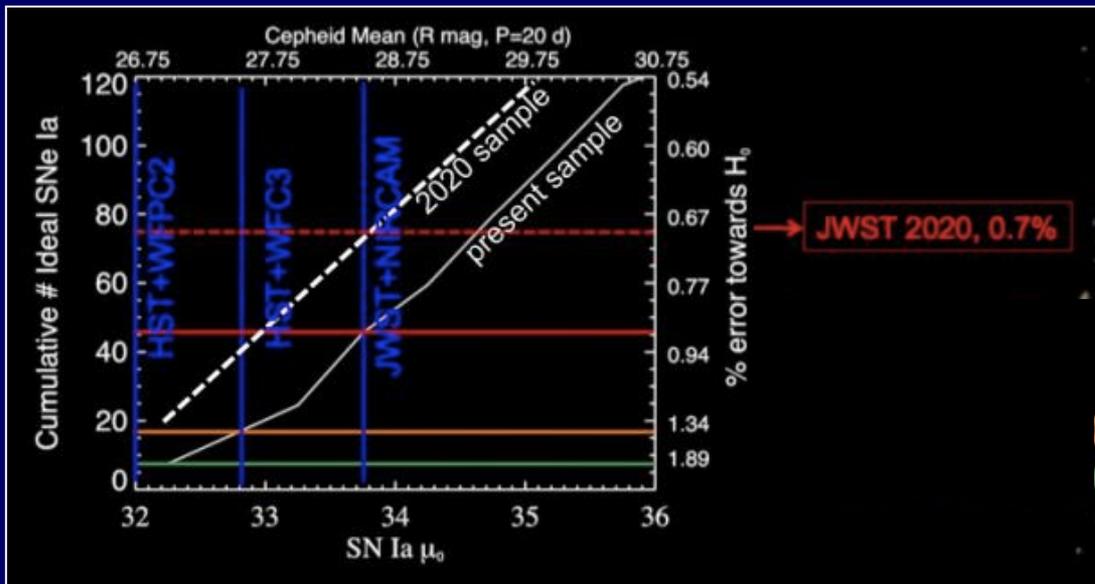
Where and when did the Hubble Sequence form? How did the heavy elements form?



- Galaxy assembly is a process of hierarchical merging
- Components of galaxies have variety of ages & compositions
- Observations:
 - NIRCcam imaging
 - Spectra of 1000s of galaxies



The dark Universe

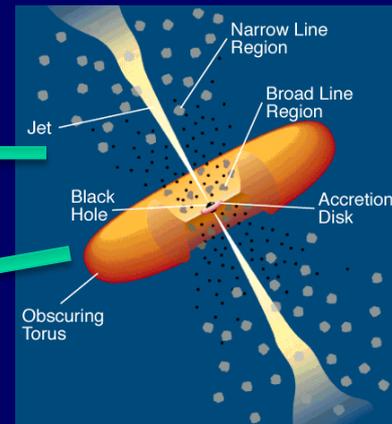
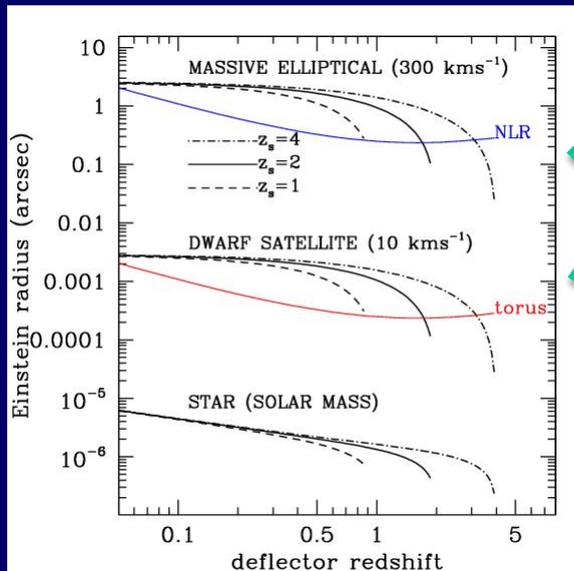


Cepheid distances to SNIa host galaxies constrains H_0

Riess et al

Lensing of AGN in the MIR picks out dwarf satellite mass without microlensing by stars

Treu et al



What are the physical processes that determine galaxy properties?

What about starbursts and black holes?

- Observations:

- MIR spectroscopy
- Velocity dispersion
- MIR emission lines

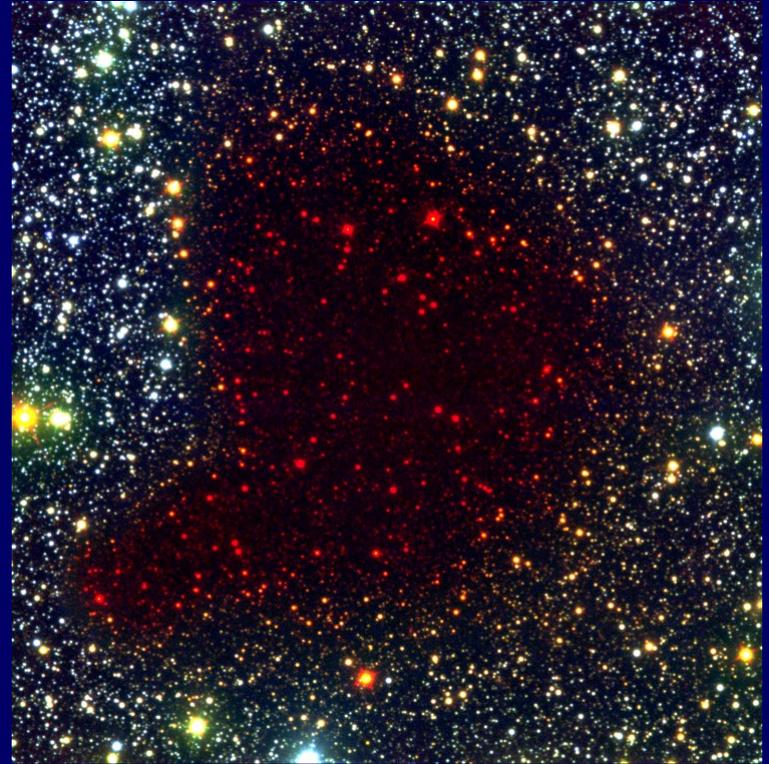
- Global scaling relations between luminosity, size, kinematics and metallicity.
- Tight correlation between mass of central black holes and surrounding galaxy

HST + radio image of active galaxy



How do proto-stellar clouds collapse?

- Stars form in small regions collapsing gravitationally within larger molecular clouds.
- We can see through thick, dusty clouds in the infrared.
- Protostars begin to shine within the clouds, revealing temperature and density structure.
- Observations:
 - Deep NIR and MIR imaging of dark clouds and proto-stars



Barnard 68 in infrared

How does environment affect star-formation and vice-versa?

What is the sub-stellar initial mass function?

- Massive stars produce winds and radiation
 - Either disrupt star formation, or causes it.
- The boundary between the smallest brown dwarf stars and planets is unknown
 - Different processes? Or continuum?
- Observations:
 - Survey dark clouds, “elephant trunks” and star-forming regions

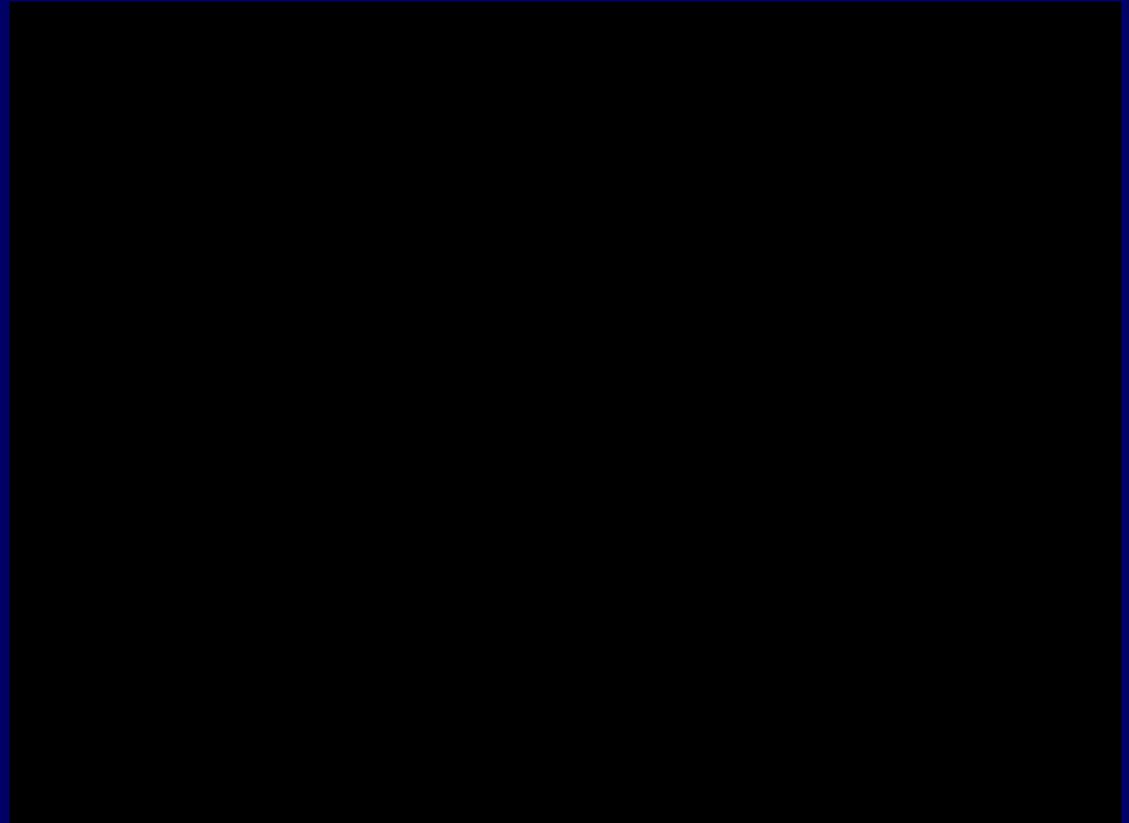


The Eagle Nebula
as seen in the infrared

How do planets form?

How are habitable zones established?

- Hundreds of known exoplanets show wide variety of properties.
- Measure constituents of exoplanet atmospheres.
- Compare circumstellar disks to our own Kuiper Belt



- Observations:

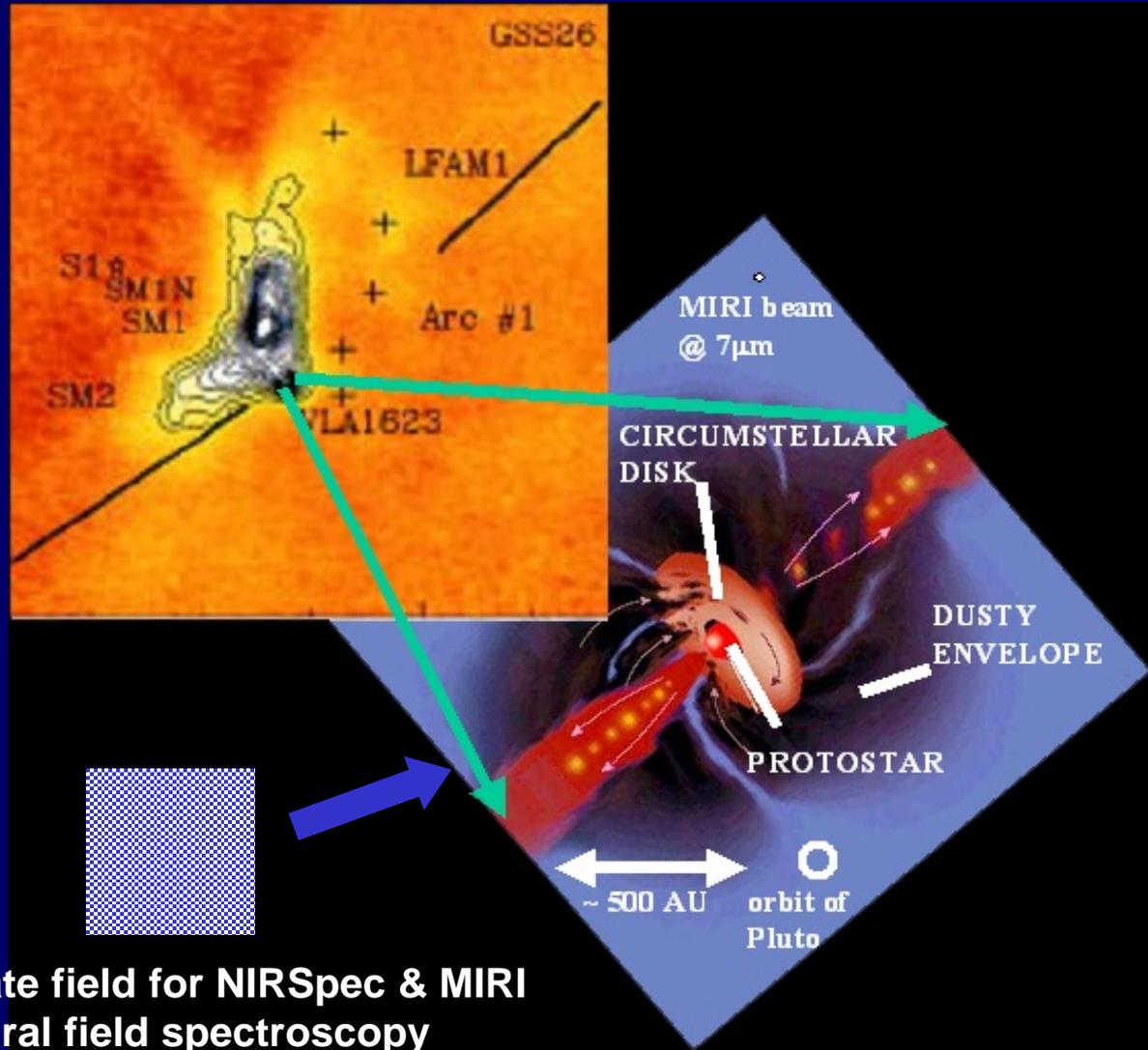
- Coronagraphy of exosolar planets
- Transits
- Kuiper Belt objects, satellites of outer planets, comets

STEREO observation of the Moon transiting the Sun

How are circumstellar disks like our Solar System?

Here is an illustration of what MIRI might find within the very young core in Ophiuchus, VLA 1623

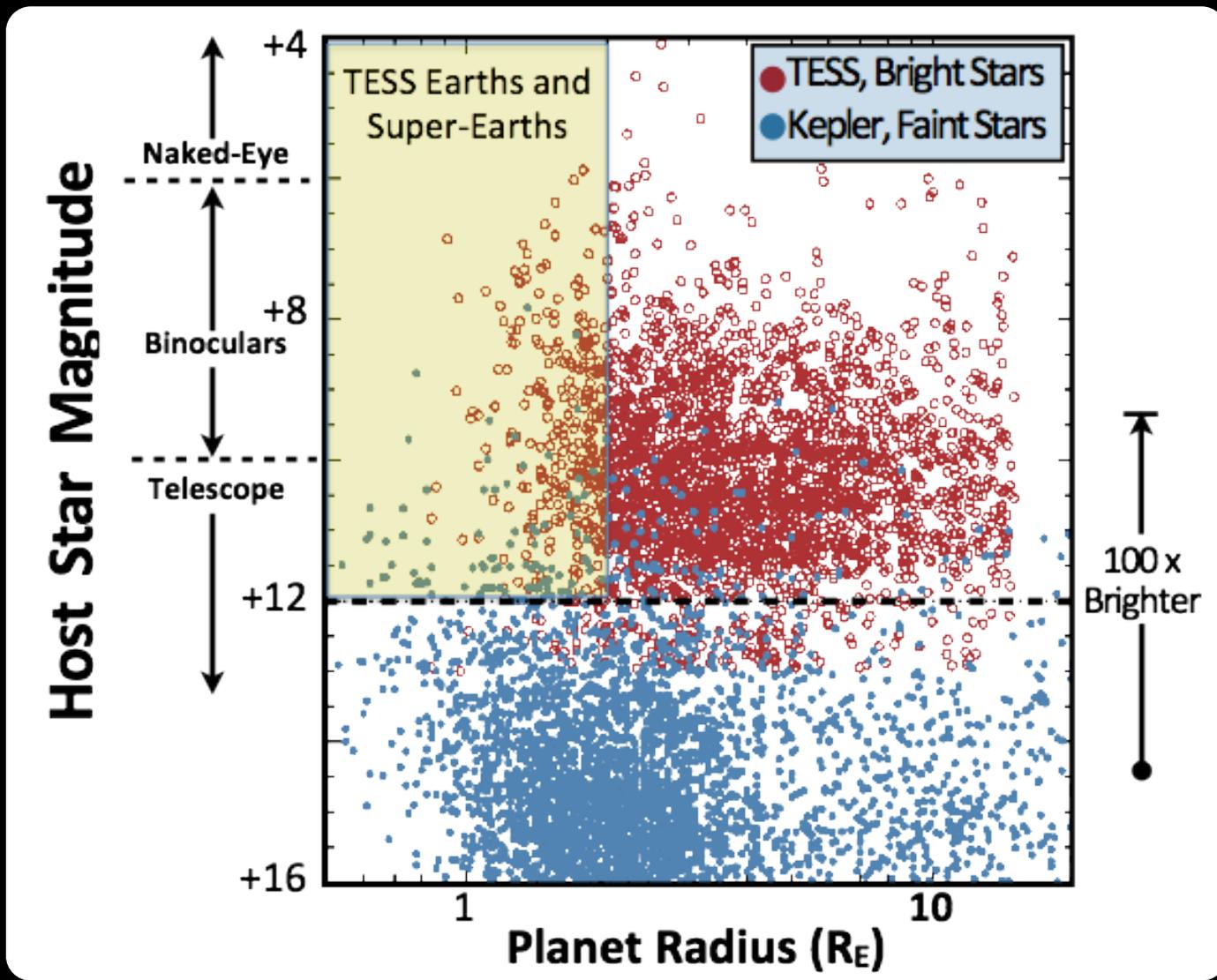
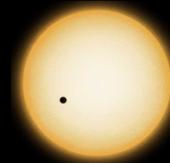
artist's concept of protostellar disk from T. Greene, Am. Scientist



approximate field for NIRSspec & MIRI
integral field spectroscopy

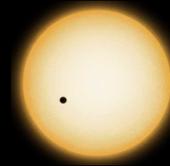


TESS will find bright Targets for JWST

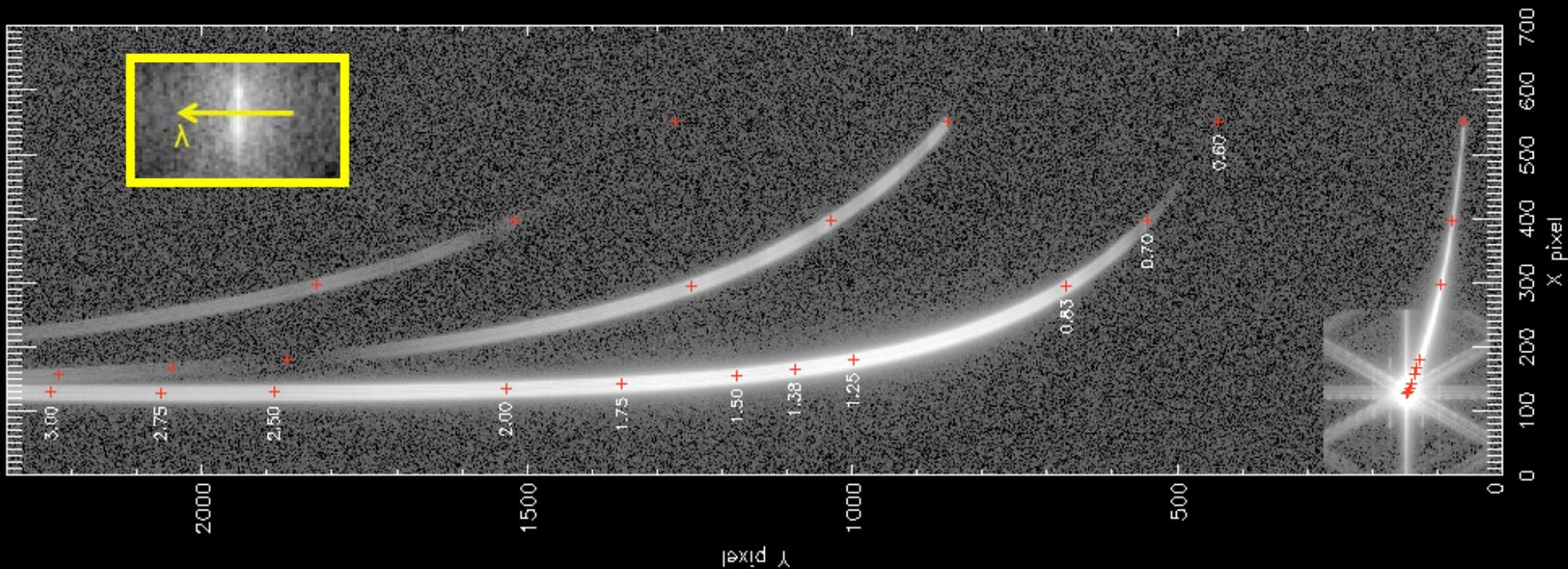




Bright Object Spectroscopy: NIRISS



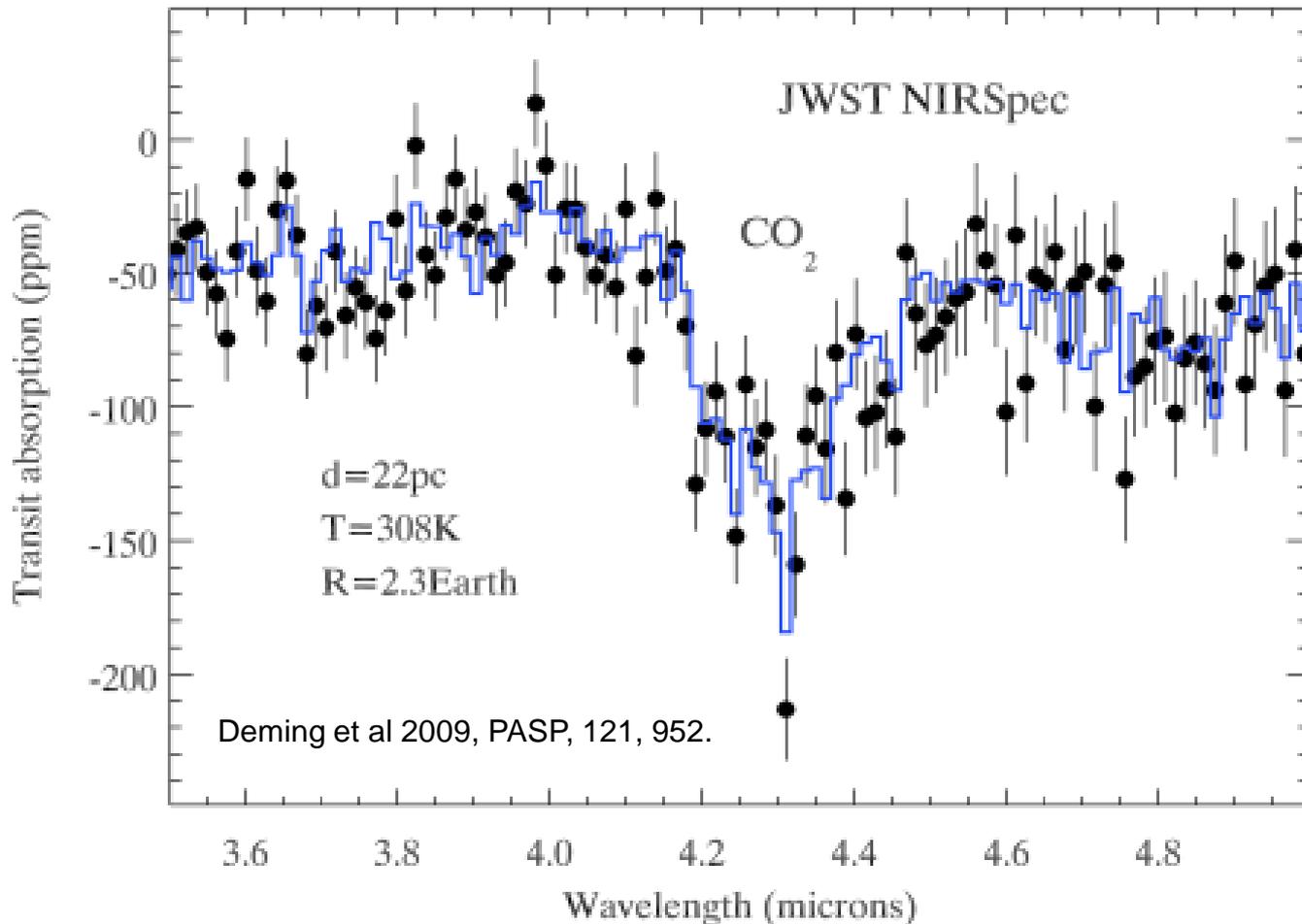
Defocused spectroscopy: 0.7 - 3.0 μm



JWST Superearth Simulation: CO₂

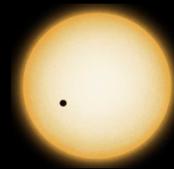


- 85 hour observations of 2.3 R_{Earth}





JWST will Image Young Jupiters

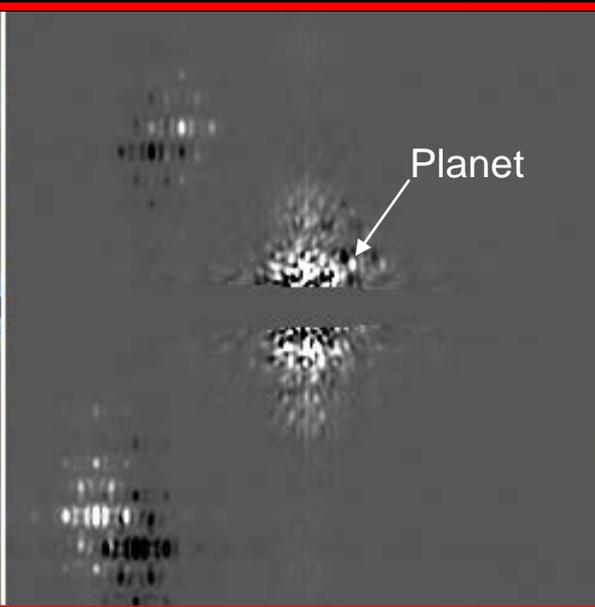


Simulations by John Krist

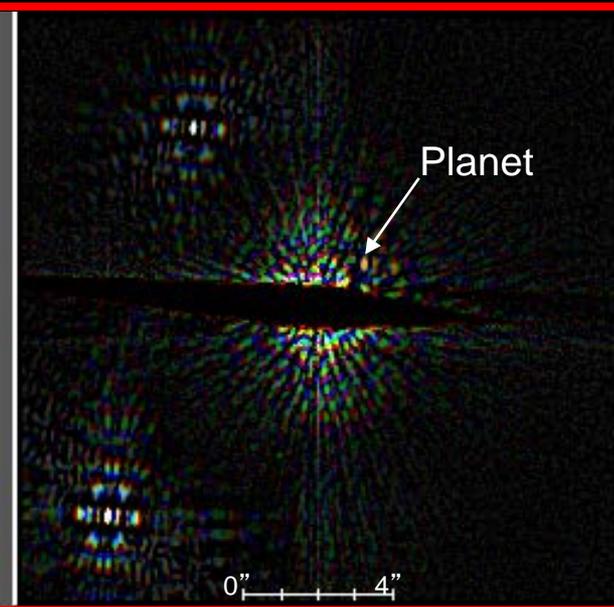
Multi-filter
Combined, Unsubtracted



F460M
Orient 1 – Orient 2 (10°)



Multi-filter
Combined, Subtracted



Red = F460M

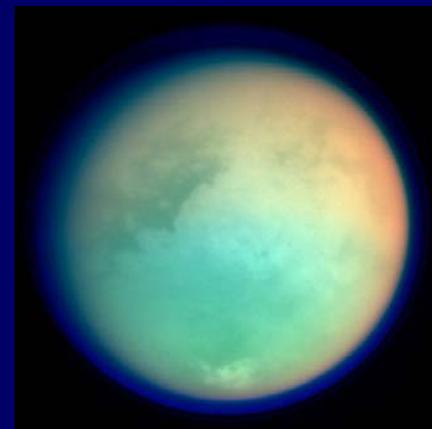
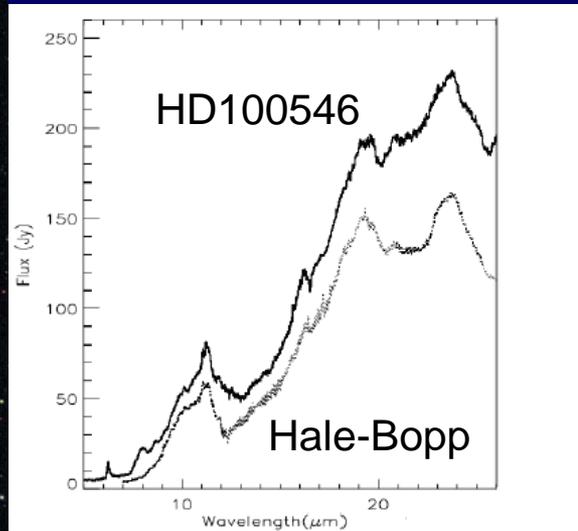
Green = F410M

Blue = F360M

- 1 Gyr-old M0V star @ 4 pc
- 2 M_{Jup} planet @ 7 AU
- 5000 sec / filter / orientation

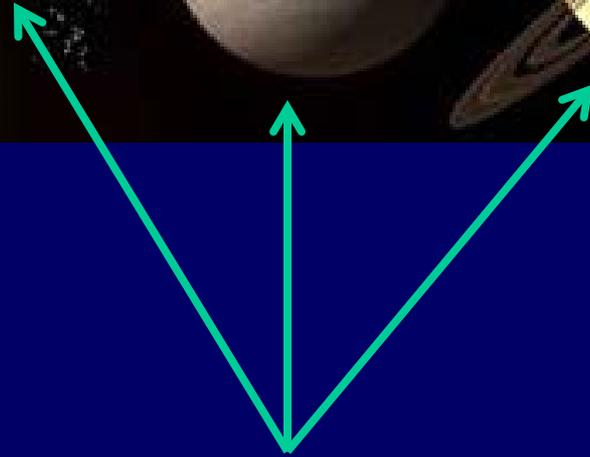
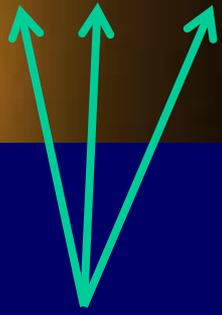


Within our Solar System: The Planets



KBOs

Titan



Mercury,
Venus,
Earth: no

Mars, Jupiter,
Saturn: some
modes

Uranus,
Neptune: yes

Can JWST observe:



Yearly Themes



- ✓ **2013: Instrument Integration:** The Science instruments will be finished and begin their testing as an integrated science payload
- ✓ **2014: Manufacturing the Spacecraft:** Construction will commence of the spacecraft that will carry the science instruments and the telescope
- ✓ **2015: Assembling the Mirror:** The mirror segments, secondary mirror and aft optics will all be assembled into the telescope
- ✓ **2016: Observatory Assembly:** The three main components of the observatory will be completed (instruments, telescope, spacecraft)
- ✓ **2017: Observatory Testing:** The three main components of the observatory will be tested and readied for assembly (instruments, telescope, spacecraft) into a single unit
- ✓ **2018: Kourou Countdown:** All parts of the observatory will be brought together, tested and readied for launch in Kourou, French Guiana



JWST Schedule



2012			2013			2014			2015			2016			2017			2018																																																					
J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D

OTE = Optical Telescope Element

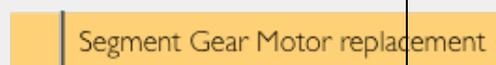
OTIS = Optical Telescope + ISIM

k months of critical path (mission pacing) slack

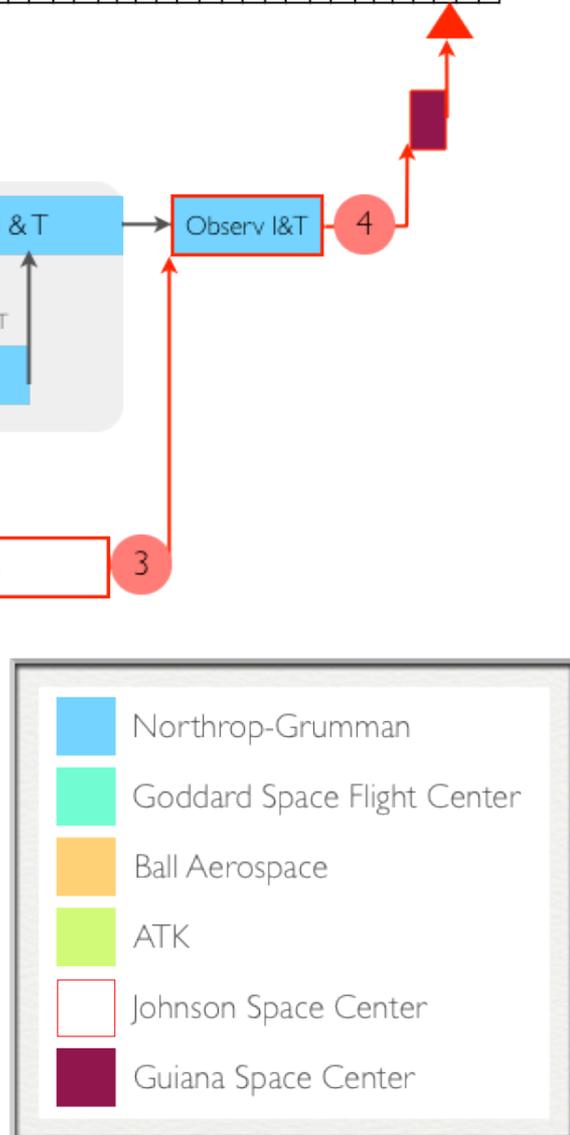
Spacecraft



Science Instruments



Telescope



Red = Critical Path

As of May 30, 2013

- Northrop-Grumman
- Goddard Space Flight Center
- Ball Aerospace
- ATK
- Johnson Space Center
- Guiana Space Center



Milestone Performance



- Since the September 2011 replan JWST reports high-level milestones monthly to numerous stakeholders

	Total Milestones	Total Milestones Completed	Number Completed Early	Number Completed Late	Deferred to Next Year
--	-------------------------	-----------------------------------	-------------------------------	------------------------------	------------------------------

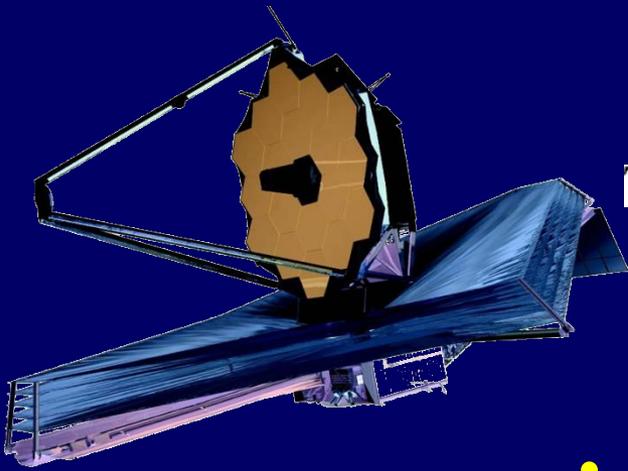
FY2011	21	21	6	3	0
FY2012	37	34	16	2	2
FY2013	41	30	15	5*	1

*Late milestones have been completed or are forecast to complete in FY13

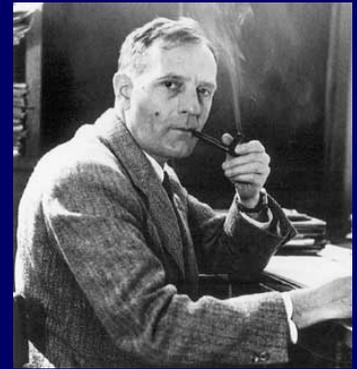
Milestones reported monthly. Search “JWST Recent Accomplishments”.

6/7/2013

Operations



THE ASTROPHYSICAL JOURNAL



Astronomer

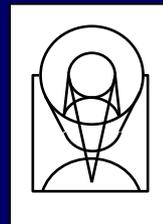
- STScI has been designated as Science Operations Center
- GO, Treasury and GTO programs similar to HST

JWST at L2

Ka
S



DSN



STScI



TAC



Getting Ready to Observe



- **Science Operations Design Reference Mission (search JWST SODRM)**
 - Includes wide range of possible observations, all instruments, all modes
 - Includes detailed observing sequences
 - Starting point for improvements in efficiency, scheduling limitations, fuel consumption, slews, momentum, data volume, and thermal, etc.
- **Exposure Time Calculator online (search JWST ETC)**
 - <http://jwstetc.stsci.edu/etc/>
- **Workshops at STScI for future observers, starting March 2015**
- **Observing proposals due 1 year before launch**
 - Guaranteed Time Observers (instrument teams, interdisciplinary scientists) will declare plans before announcement of opportunity
 - Discussing Early Release Observations (EROs), Early Release Science
 - Community input via JSTAC (committee advising STScI)

SODRM: 1 year of realistic JWST science programs.

- We've* written >1year of mock JWST observations, anticipating the kinds of science we expect GOs and GTOs will propose.
- We call it “SODRM 2012” (Science Operations Design Reference Mission). On the web: <http://www.stsci.edu/jwst/science/sodrm>
- Includes 70 science programs, from solar system to exoplanets to cosmology. Exercises all 4 JWST science instruments, and all major modes.



If you feel important science or observational technique are missing, please contact Jane.Rigby@nasa.gov, to contribute to the next update!

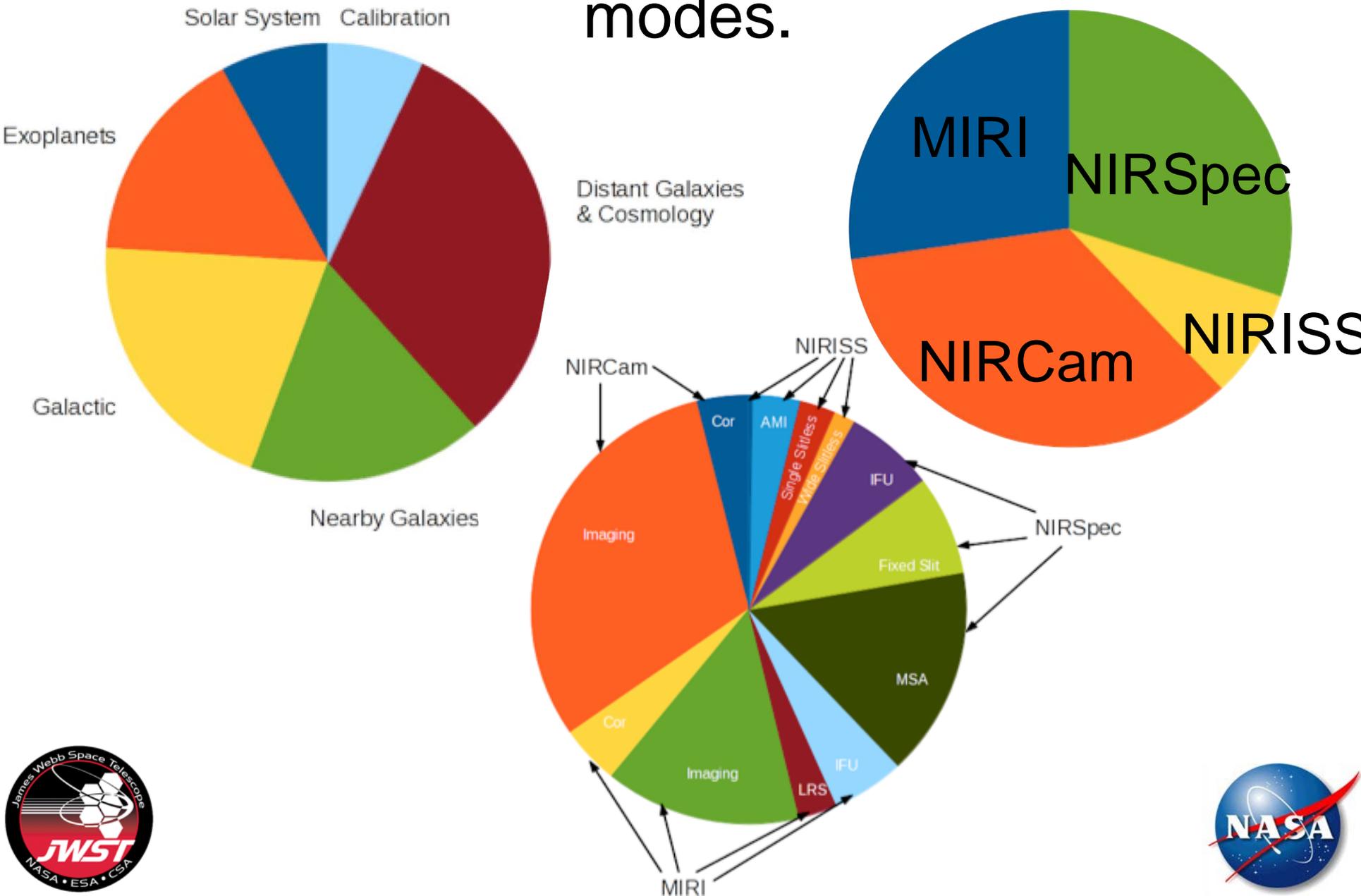
- Programs were designed with APT interface, & digested by early version of planning software. Provides early testing of in-development ground system.
- We are now analyzing the daily data volume, efficiency, schedulability, and propellant use of the science programs in the SODRM.



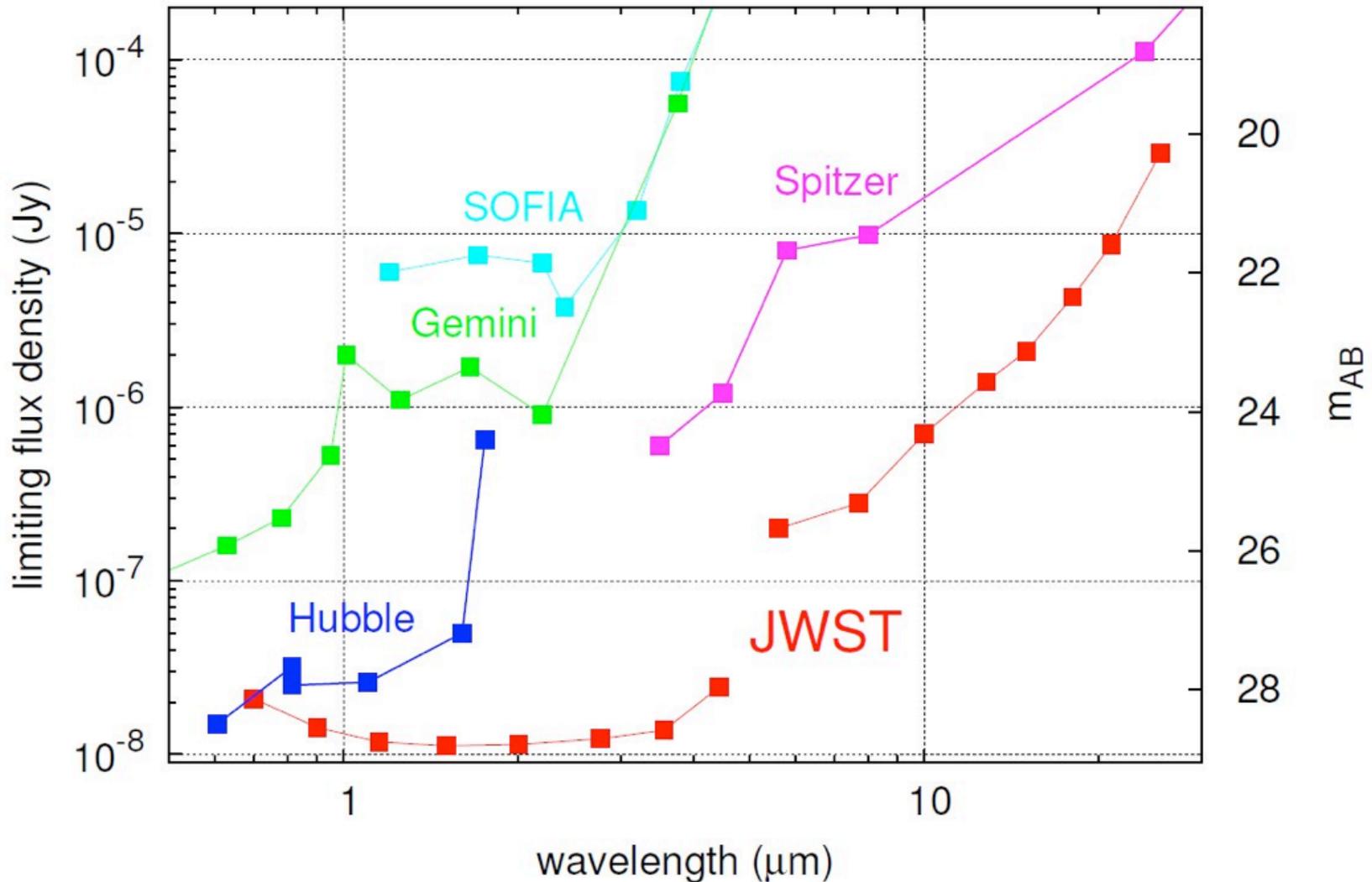
* (We = 50 scientists across the JWST community, led by STScI.)



SODRM uses all JWST instruments & modes.

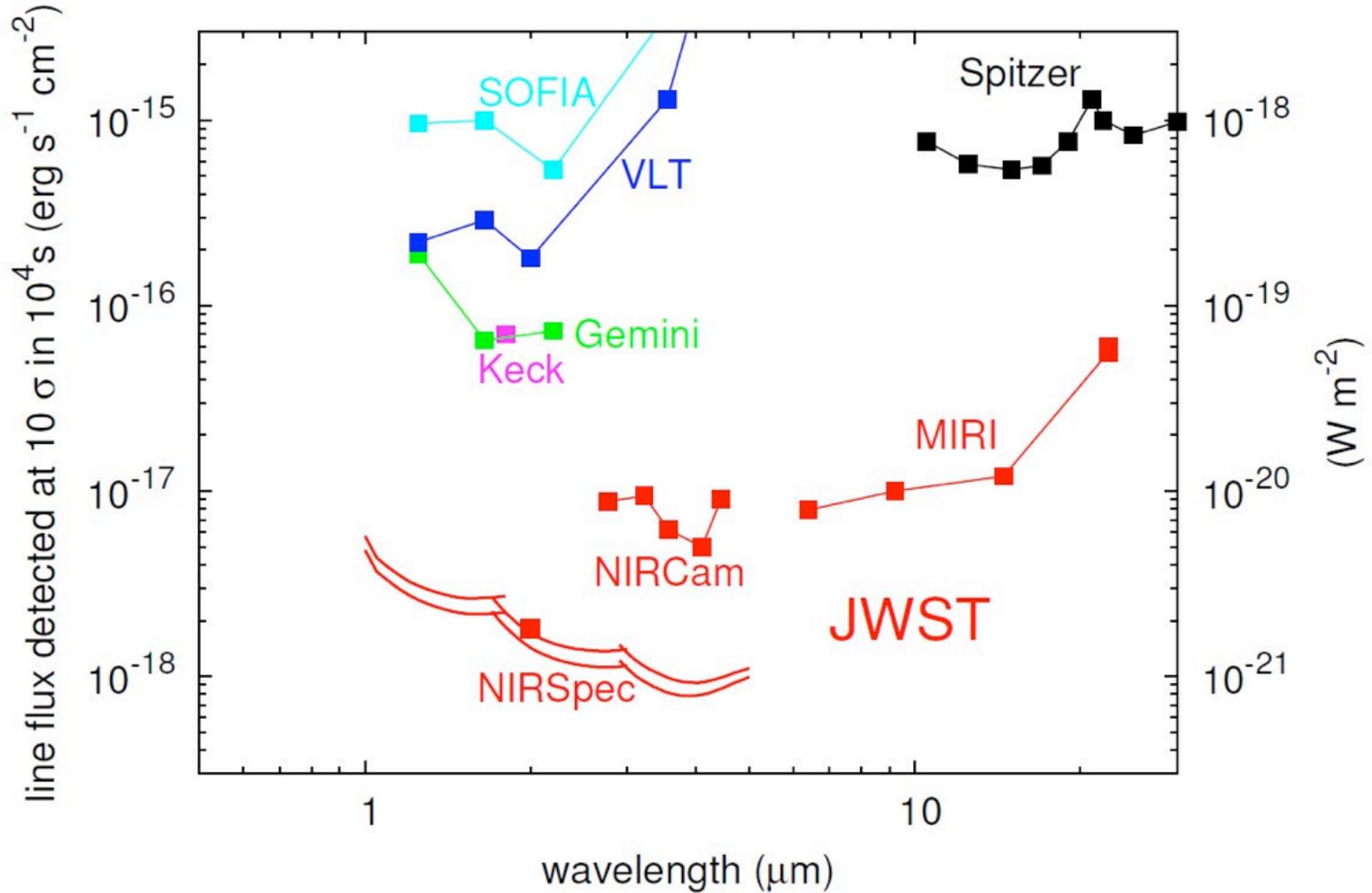


photometric performance, point source, 10σ in 10^4 s



<http://www.stsci.edu/jwst/science/sensitivity>

R=600-2400 spectroscopy, emission line, point source

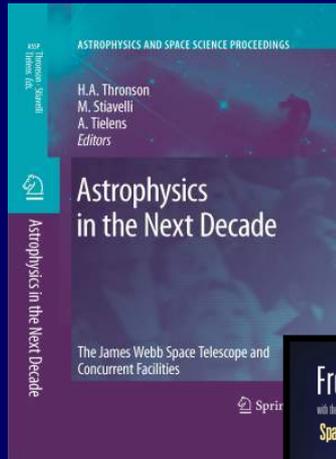


<http://www.stsci.edu/jwst/science/sensitivity>

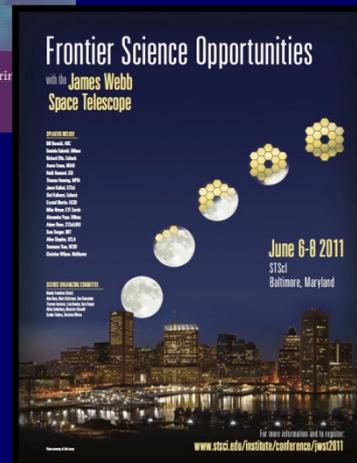
Want to Learn More about JWST?



Gardner et al. 2006,
Space Science Reviews, 123/4, 485
<http://jwst.nasa.gov/scientists.html>



2007 Conference
Proceedings
Read on-line



2011 Conference
Presentations
and video on-
line at STScI

- White Papers:**
- JWST in Decadal Survey
- Solar System Objects
- Dark Energy
- Transiting Planets
- Coronagraphy
- Planetary Systems
- Stellar Pops
- Star Formation
- Galaxy Assembly
- First Light
- Astrobiology
- Scientific Capabilities
- Observation Planning

Science White Papers
<http://www.stsci.edu/jwst/science/whitepapers/>

NASA National Aeronautics and Space Administration

FAST FACTS | FAQ | GLOSSARY | CONTACT US

THE JAMES WEBB SPACE TELESCOPE

HOME

STATUS

- Current Status
- Recent Accomplishments
- What's Next?

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FOR EDUCATORS

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Recent Accomplishments

Updated May 8, 2013

The following list contains a record of program and project accomplishments for the James Webb Space Telescope. The left column gives the original due date, the middle column gives the item accomplished, and the right column indicates the schedule performance with green text denoting items accomplished earlier than planned, black text for items completed on schedule, and red text for items finishing later than planned. The list will be updated approximately every month.

The image below points out various major hardware components of the facility referred to in the list to orient the reader. (Click to enlarge image.)

Due Date	Item Accomplished	Completion Date
April 2013	Sunshield Template Membrane Layer #2 fabrication complete	April 13, 2013
	Spacecraft-to-ground communications subsystem critical design review	March 12, 2013

Project Milestones updated monthly

Social Media

www.stsci.edu/jwst

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James Webb Space Telescope JWST Software

- JWST Overview
- Advisory Committee
- Science
- Optical Telescope Element
- Instruments
- Operations
- Software Tools
- Instrument Architecture
- Glossary
- Meetings

WebbPSF: The program WebbPSF models Point Spread Functions for the James Webb Space Telescope, using predicted wavefronts based on the optical requirements and error budgets for the telescope and instruments. WebbPSF can produce monochromatic and broadband PSFs for all instruments in direct imaging and coronagraphic modes; spectroscopic modes are not yet supported.

Astronomer's Proposal Tool: APT is the operational tool for writing HST proposals and it is being modified to also write JWST proposals. You can download the current operational version of APT here and look at the current draft version for JWST by clicking on File>New>New JWST Proposal. Note that at this point the observation templates generally reflect what has been developed for the on board scripts and do not necessarily all planned functionality.

JWST Prototype ETC: This JWST prototype Exposure Time Calculator (ETC) is a web-based application that assists users in exploring JWST's science capabilities. The ETC calculates Signal-to-Noise Ratio (SNR) for a given exposure time and for JWST's science instruments.

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Facebook | Twitter | YouTube

Astronomy Software Tools ETC, PSF, APT

Agenda

Jonathan Gardner	Deputy Senior Project Scientist	Science
Amber Straughn	Deputy Project Scientist for Communications	Outreach
Mark Clampin	Observatory Project Scientist	Observatory Progress
Matt Greenhouse	ISIM Project Scientist	ISIM Progress