



Large International Physics Projects: James Webb Space Telescope

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James Webb Space Telescope (JWST)

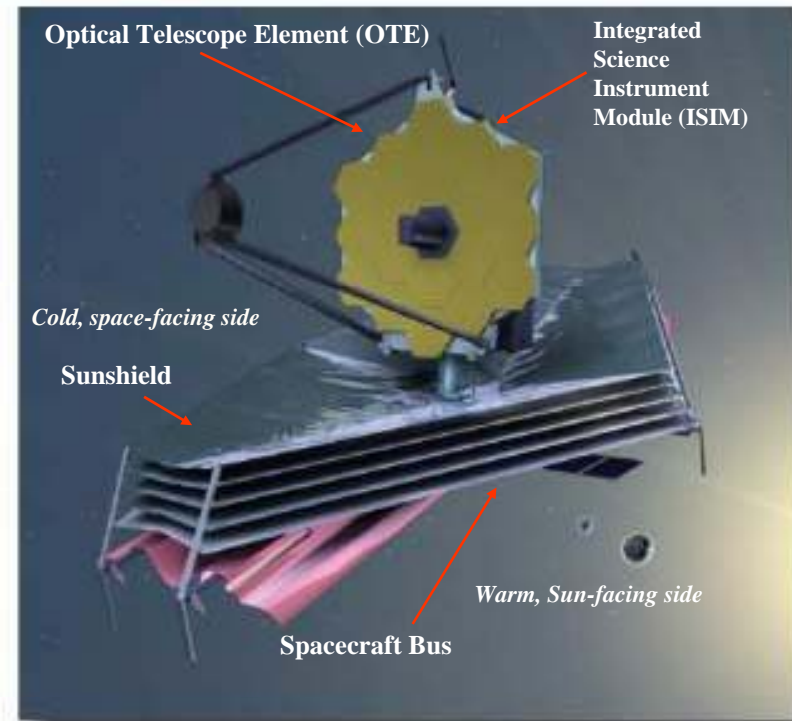
Organization

- Mission Lead: Goddard Space Flight Center
- International collaboration with ESA & CSA
- Prime Contractor: Northrop Grumman Space Technology
- Instruments:
 - Near Infrared Camera (NIRCam) – Univ. of Arizona
 - Near Infrared Spectrograph (NIRSpec) – ESA
 - Mid-Infrared Instrument (MIRI) – JPL/ESA
 - Fine Guidance Sensor (FGS) – CSA
- Operations: Space Telescope Science Institute

Description

- Deployable infrared telescope with 6.5 meter diameter segmented adjustable primary mirror
- Cryogenic temperature telescope and instruments for infrared performance
- Launch June 2013 on an ESA-supplied Ariane 5 rocket to Sun-Earth L2
- 5-year science mission (10-year goal)

www.JWST.nasa.gov



JWST Science Themes



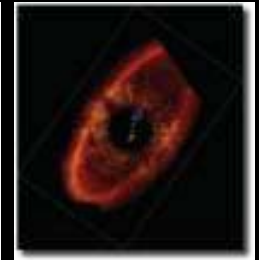
End of the dark ages: First light and reionization



The assembly of galaxies



Birth of stars and proto-planetary systems

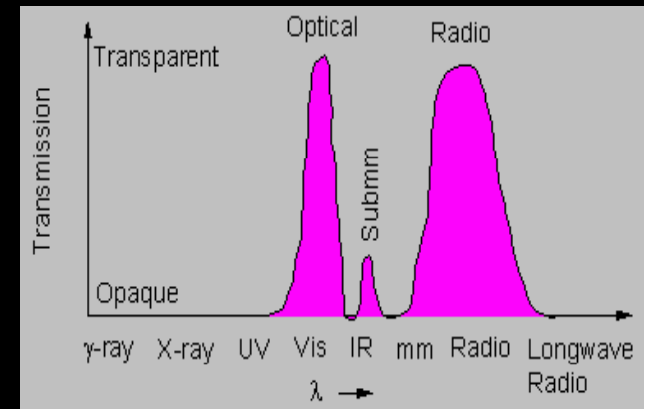
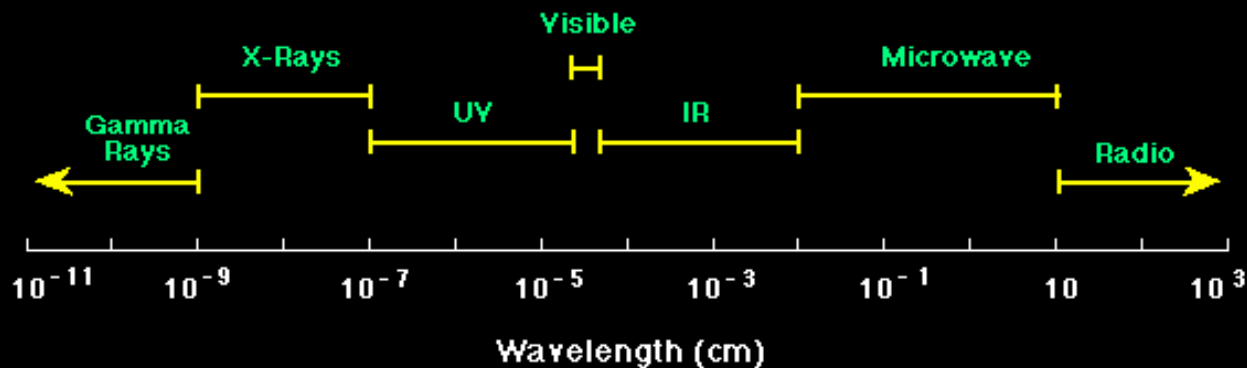


Planetary systems and the origin of life



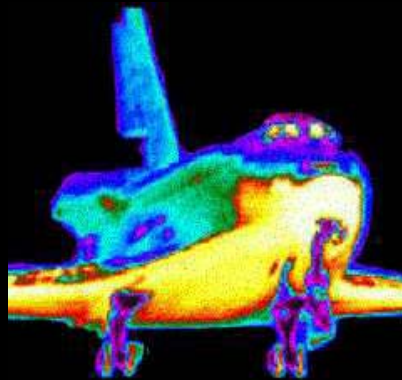
Light comes in more colors than our eyes can see

Light from the first galaxies is **redshifted** from the visible into the infrared.



Infrared is heat radiation

Our eyes can't see it, but our skin can feel it





JWST Project History

- **1989 conference at STScI on future space telescopes**
- **1995 HST and Beyond report, Alan Dressler et al., calls for > 4 m IR telescope, and planet-finding interferometer**
- **1995, study begins at GSFC to lead worldwide team**
- **1996, Dan Goldin announces to AAS to standing ovation**
- **1996, international partnership discussions begin**
- **2000, National Academy of Sciences Decadal Survey gives highest priority for large projects**
- **2001, international agreement with European and Canadian Space Agencies**
- **2002, international science team selected**
- **2002, prime contract selected (TRW, became Northrop Grumman), JWST name chosen**
- **2007, all 10 technologies mature**
- **2008, Preliminary Design Review (March) and Non-Advocate Review**
- **2013, launch by Ariane 5**
- **2014-2019, primary mission**
- **2019-2024, extended mission**

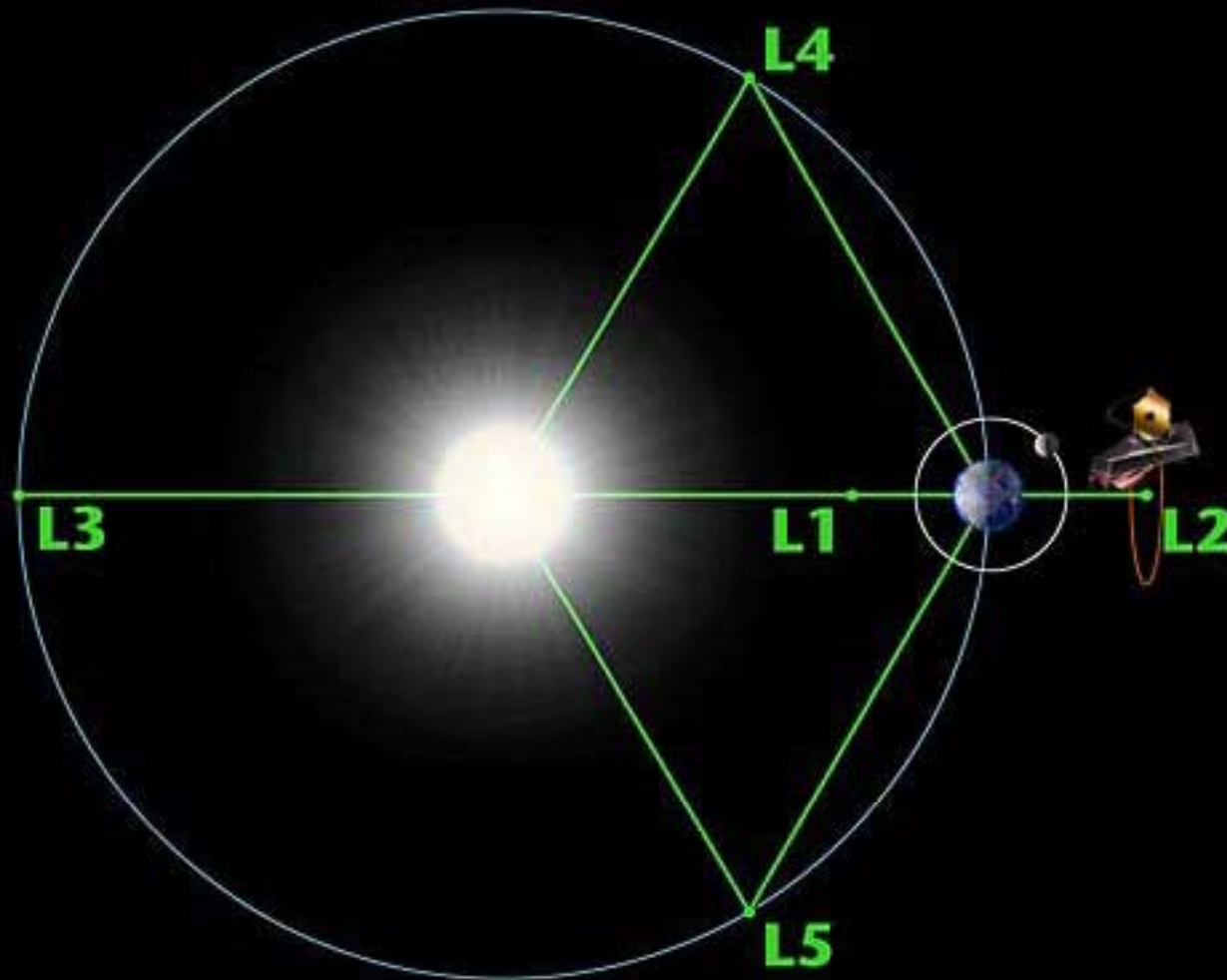


JWST Project Partnerships

- **NASA leads partnership**
 - NASA GSFC
 - Leads NASA effort
 - ISIM (instrument module)
 - Microshutters for NIRSpec
 - NASA MSFC large optics development and test
 - NASA JSC large test facility
 - JPL optical control algorithms, US half of Mid IR instrument
 - Northrop Grumman prime contractor
 - Ball Aerospace
 - ATK
 - ITT (was Kodak)
 - University of Arizona, NIRCам instrument, with Lockheed Martin
 - IR detectors from Rockwell (now Teledyne) and Raytheon
 - STScI flight and science operations
- **ESA contributes Ariane launch vehicle, NIRSpec instrument**
- **European Consortium contributes half of Mid IR instrument**
 - Led by G. Wright at UK ATC in Edinburgh
 - 17 nations and organizations contribute; guarantee by ESA
- **CSA contributes Fine Guidance Sensor, Tunable Filter Imager**



JWST Orbits the Sun-Earth Lagrange Point L2

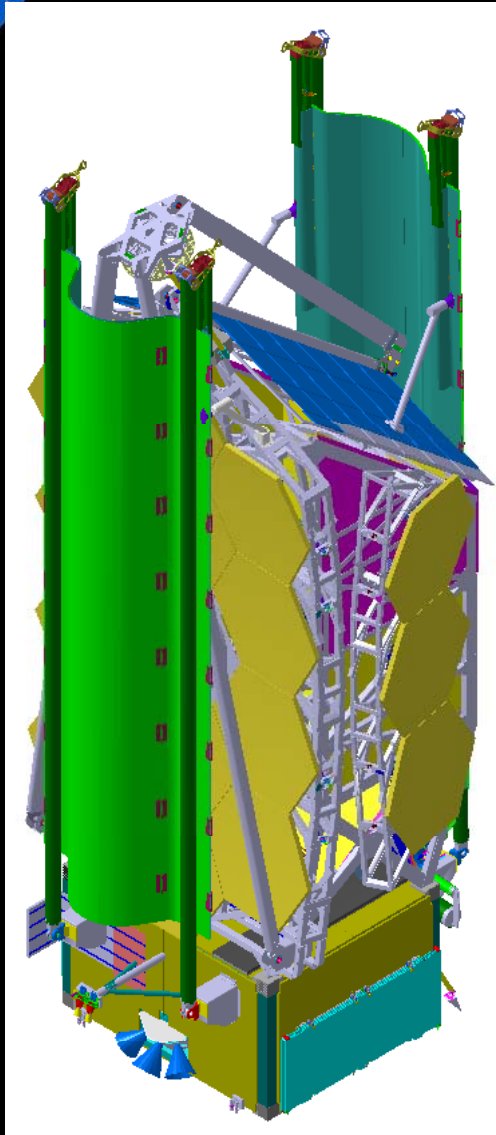




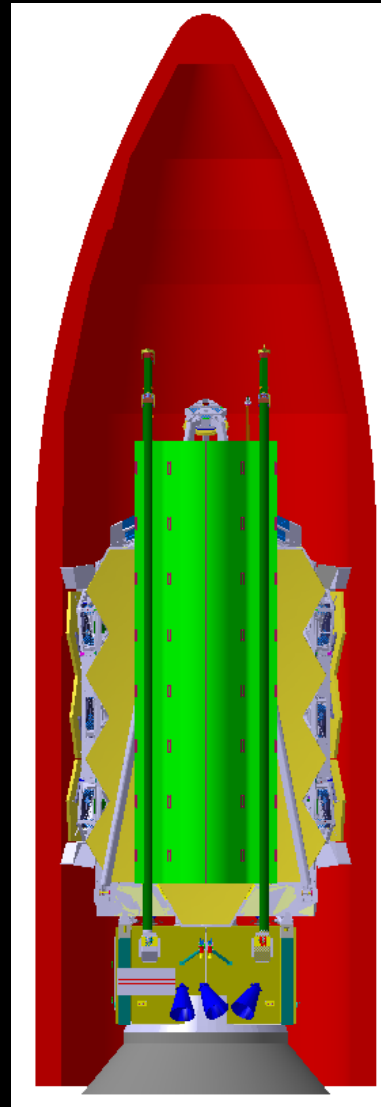
Full scale model at GSFC



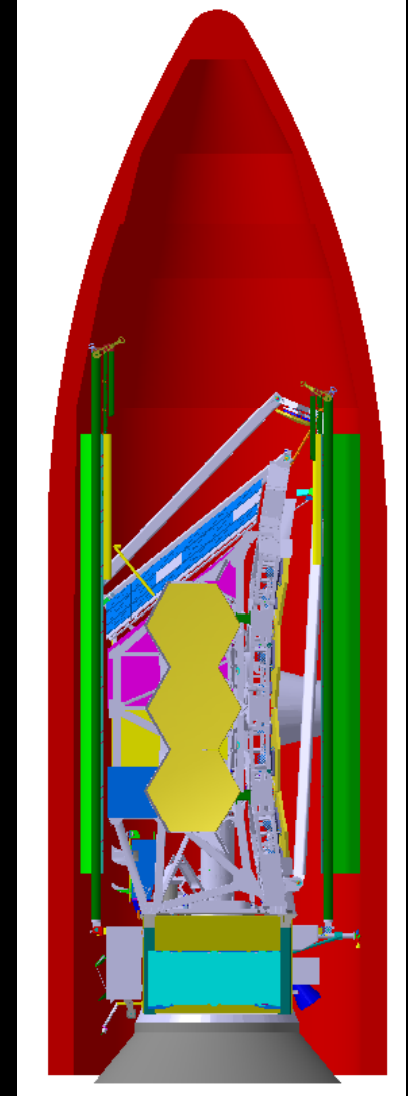
JWST folds up inside ESA-provided Ariane 5



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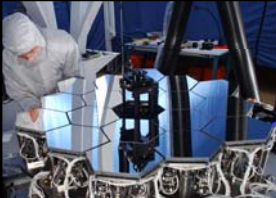


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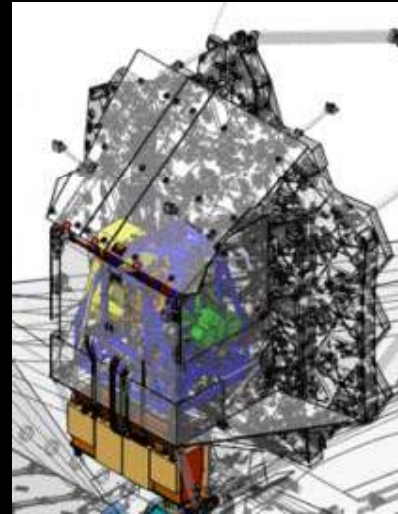


JWST Technology

Mirror Phasing Algorithms



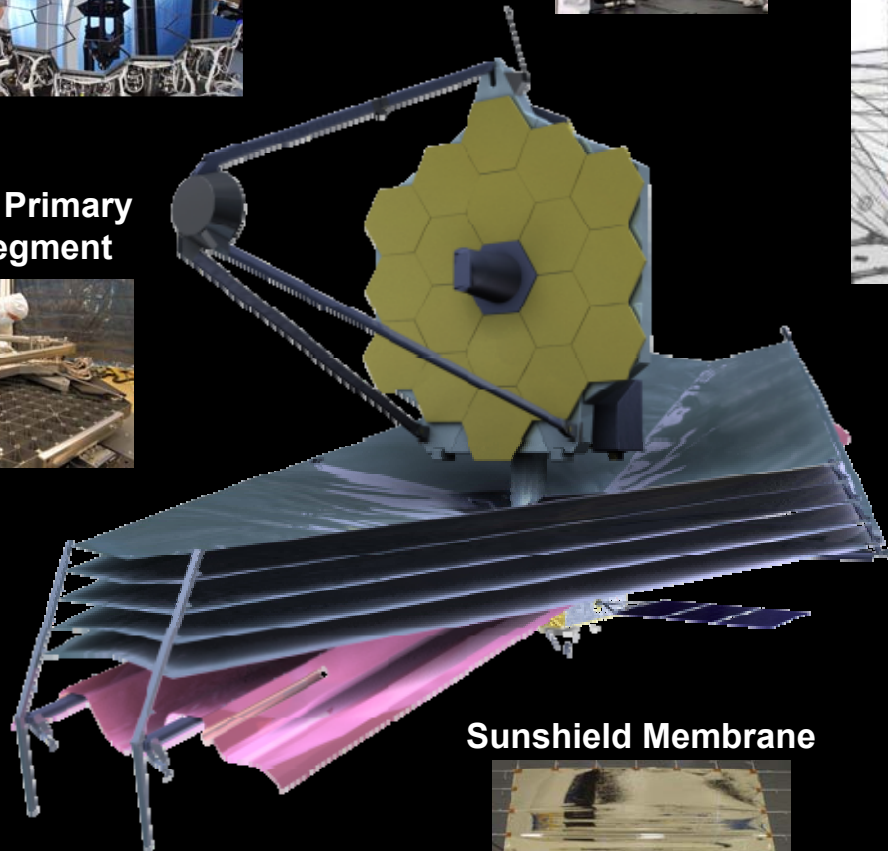
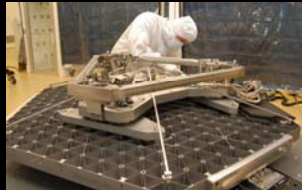
Backplane



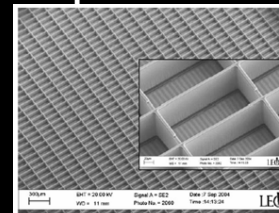
Near-Infrared Detector



Beryllium Primary Mirror Segment



μ Shutters



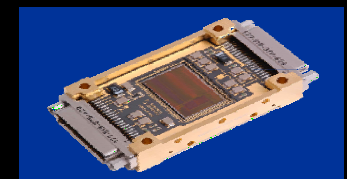
Mid-Infrared Detector



Cryocooler



Cryogenic ASICs



Sunshield Membrane



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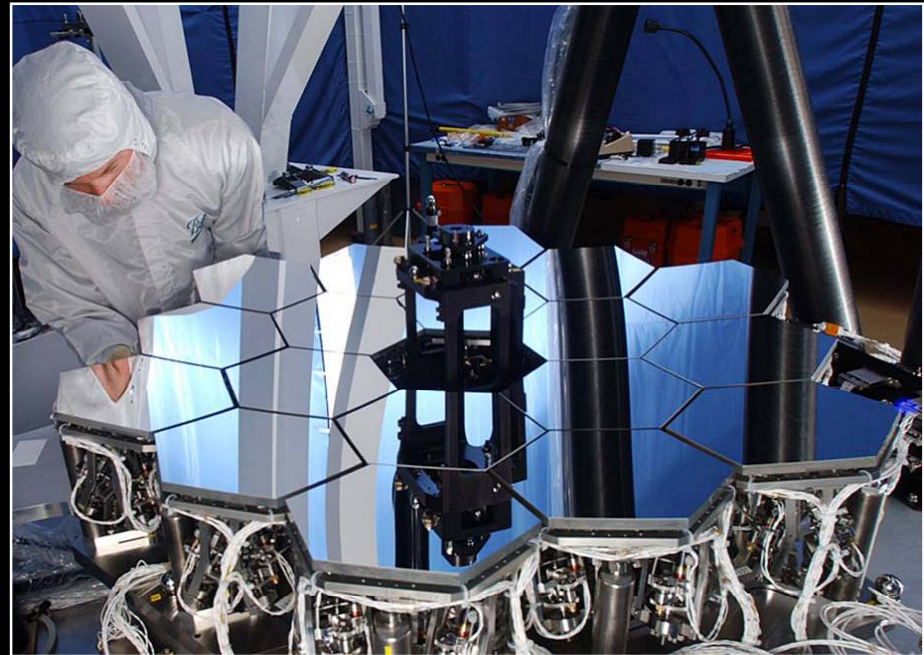
AAS



Testbed Telescope



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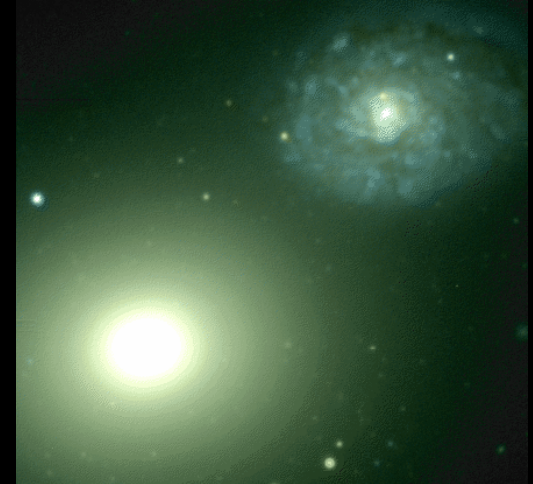
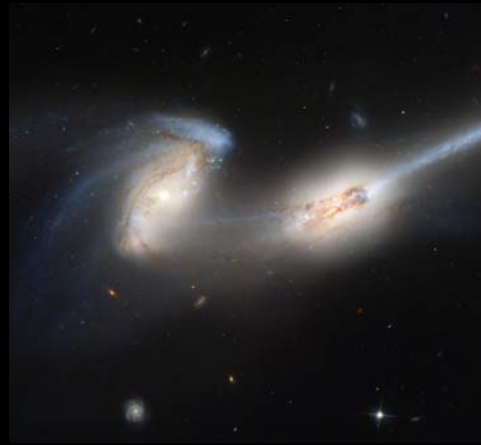
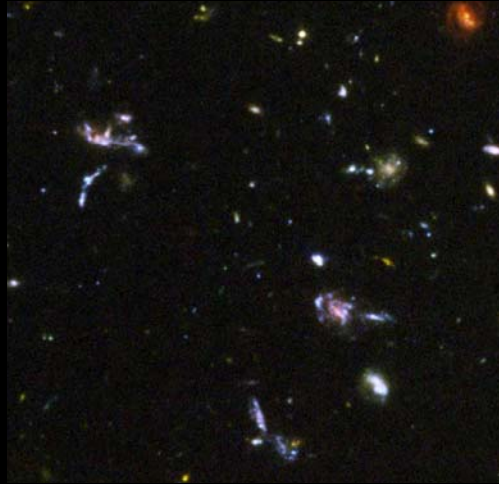


- 1/6 scale model with all the same adjustments
- Proves that all the adjustment procedures work as expected

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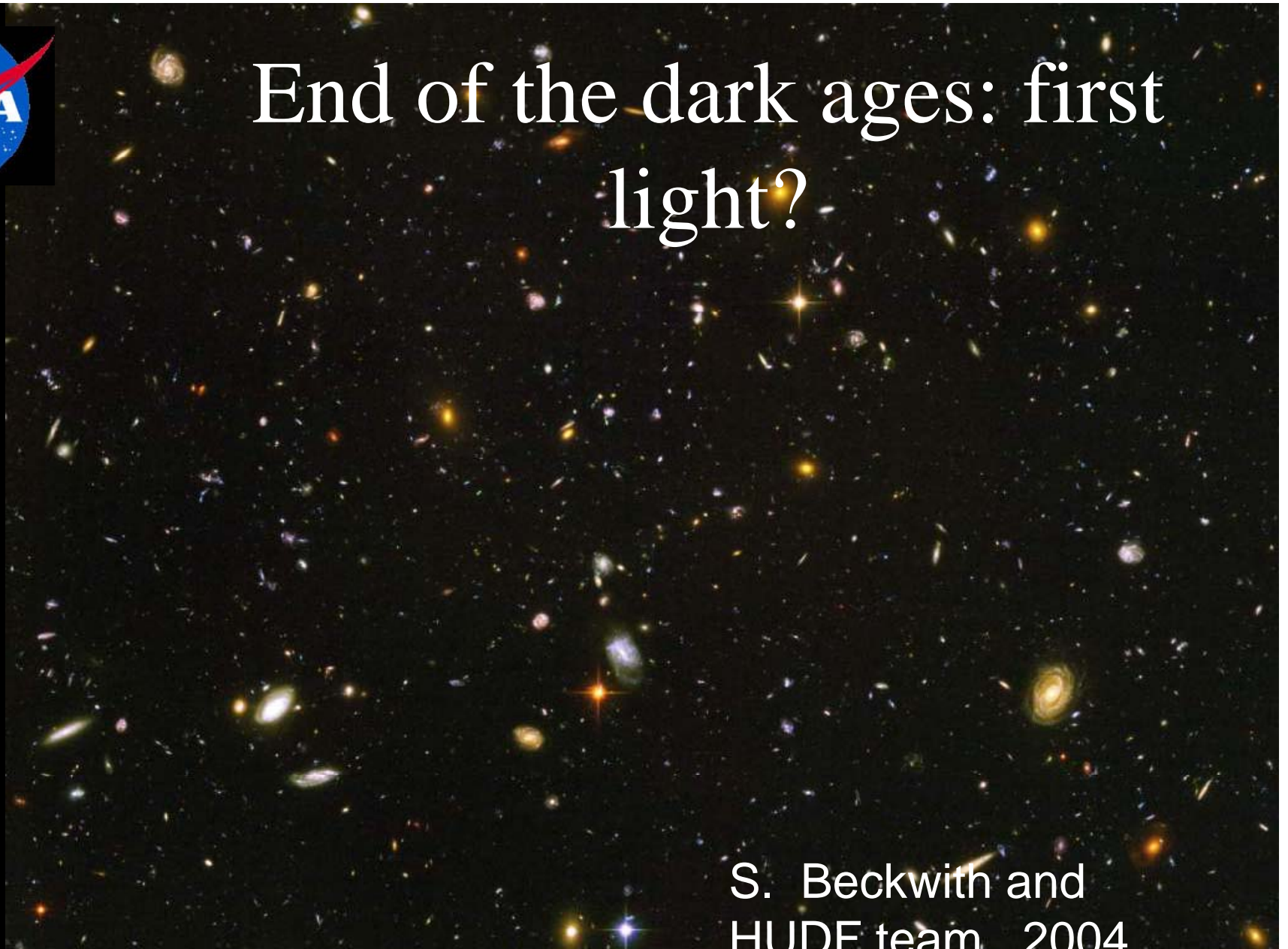
Where and when did the Hubble Sequence form? How did the heavy elements form?



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



End of the dark ages: first light?



S. Beckwith and
HUDF team , 2004



The Eagle Nebula as seen with Hubble



Feb. 15, 2005



The Eagle Nebula as seen in the infrared

M. J. McCaughrean
and M. Andersen,
1994

Feb. 15, 2000



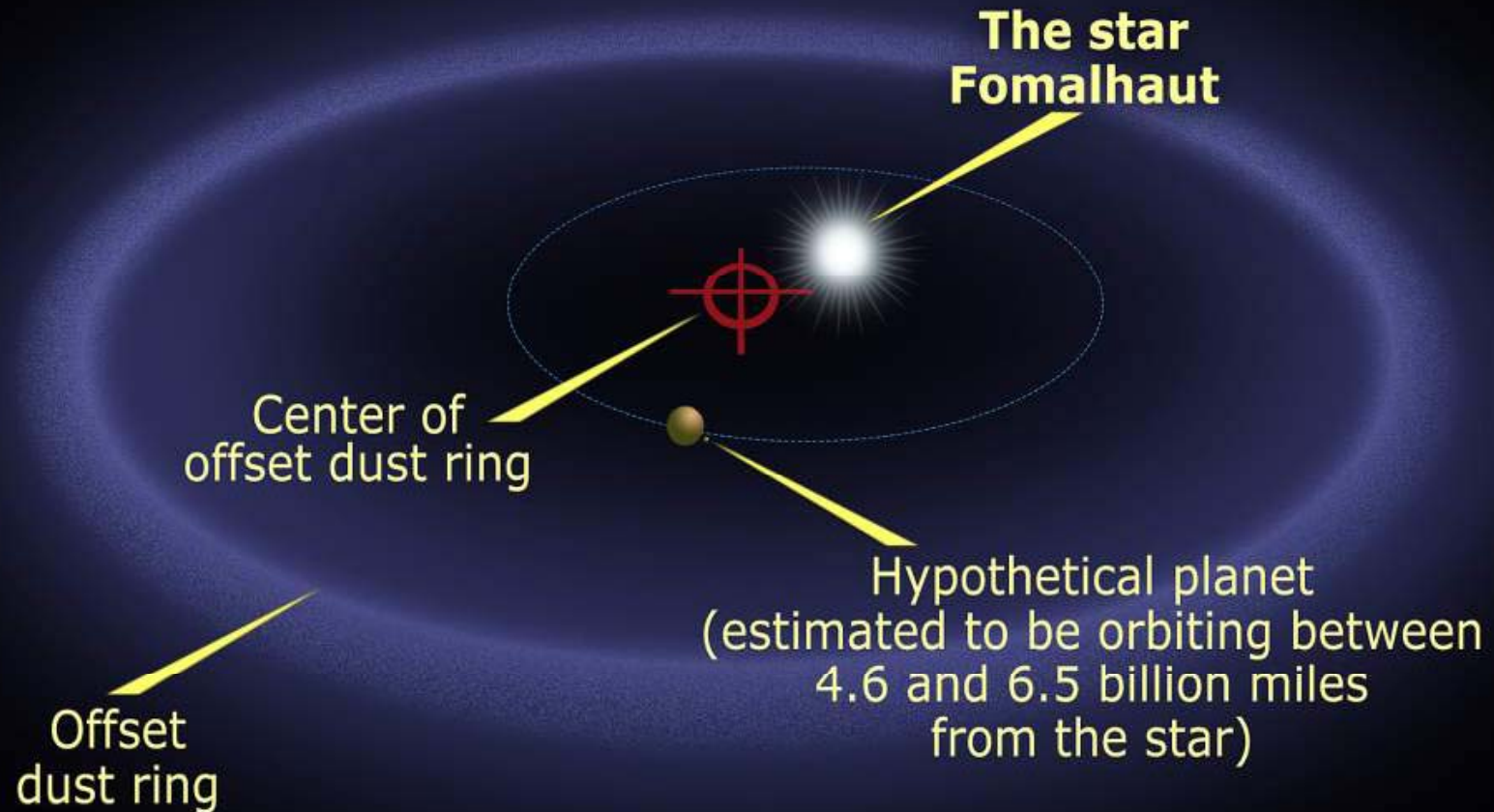
Stars in dust disks in Orion



C. R. Odell et al.
1994



Planetary systems and the origins of life



Kalas, Graham and Clampin

2005

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Primary

Secondary

- Planet blocks light from star
- Visible/NIR light (Hubble/JWST)
- Radius of planet/star
- Absorption spectroscopy of planet's atmosphere
- JWST: Look for moons, constituents of atmosphere, Earth-like planets with water

- Star blocks light from planet
- Mid-Infrared light (Spitzer/JWST)
- Direct detection of photons from planet
- Temperature of planet
- Emission from surface
- JWST: Atmospheric characteristics, constituents of atmosphere, map planets



Summary

- JWST is major international partnership based on mutual interest
- Top priority for large astrophysics projects in US, Europe, and Canada
- Extraordinary advance over Hubble, Spitzer, and ground-based telescopes
- Excellent progress towards launch in 2013



The End

And the beginning!