James Webb Space Telescope and its Instruments

John Stansberry
Steward Observatory, University of Arizona

JWST’s Science Themes

- The First Light in the Universe: Discovering the first galaxies, Reionization
- Period of Galaxy Assembly: Establishing the Hubble sequence, Growth of galaxy clusters
- Birth of Stars and Protoplanetary Systems: Physics of the IMF, Structure of pre-stellar cores, Emerging from the dust cocoon
- Planetary Systems and the Origins of Life: Disks from birth to maturity, Survey of KBOs, Planets around nearby stars

JWST has phenomenal capabilities for new astronomy! See lower left for KBO applications.

JWST Capabilities

- 25 m² collecting area using a segmented primary with 6.6-m tip-to-tip diameter
- Low infrared background: L2 orbit enables passive cooling to ~45K for primary mirror, ~35K for instruments
- Four instruments:
  - NIRCam, 0.6 - 5 µm imaging
  - NIRSpec, 0.6 - 5 µm, spectroscopy, R=100-3000 and multi-object
  - MIRI, 5-29 µm, camera + R=2500 integral field spectrometer
  - Tunable Filter, 1.7-4.3 µm R=100

Key Design Features

- Large telescope optics
- JWST’s telescope assembly is lightweight and deployable
- Making its telescope lightweight and deployable makes JWST’s large size feasible.
- Telescope assembly and scientific instruments are cold
  - The telescope and the instruments (cameras and spectrometers) attached to it need to be cold so that their own warmth does not overwhelm the faint infrared signals they are meant to detect.
- Sunshield allows the telescope and instruments to get cold
  - The cold telescope provides the phenomenal sensitivity in the IR.
  - The sunshield allows the telescope and instruments to radiate their heat to the extreme coldness of deep space.
- L2 is an ideal “Goldilocks” place for an infrared observatory
  - The Sun-Earth L2 point is far enough away from the warm Earth to provide a benign thermal environment and enable efficient operations, yet close enough for easy launch and communications.

Figure to left shows sensitivity gains over a hypothetical 30-m telescope on the ground.

Want to know more? Go to http://www.jwst.nasa.gov