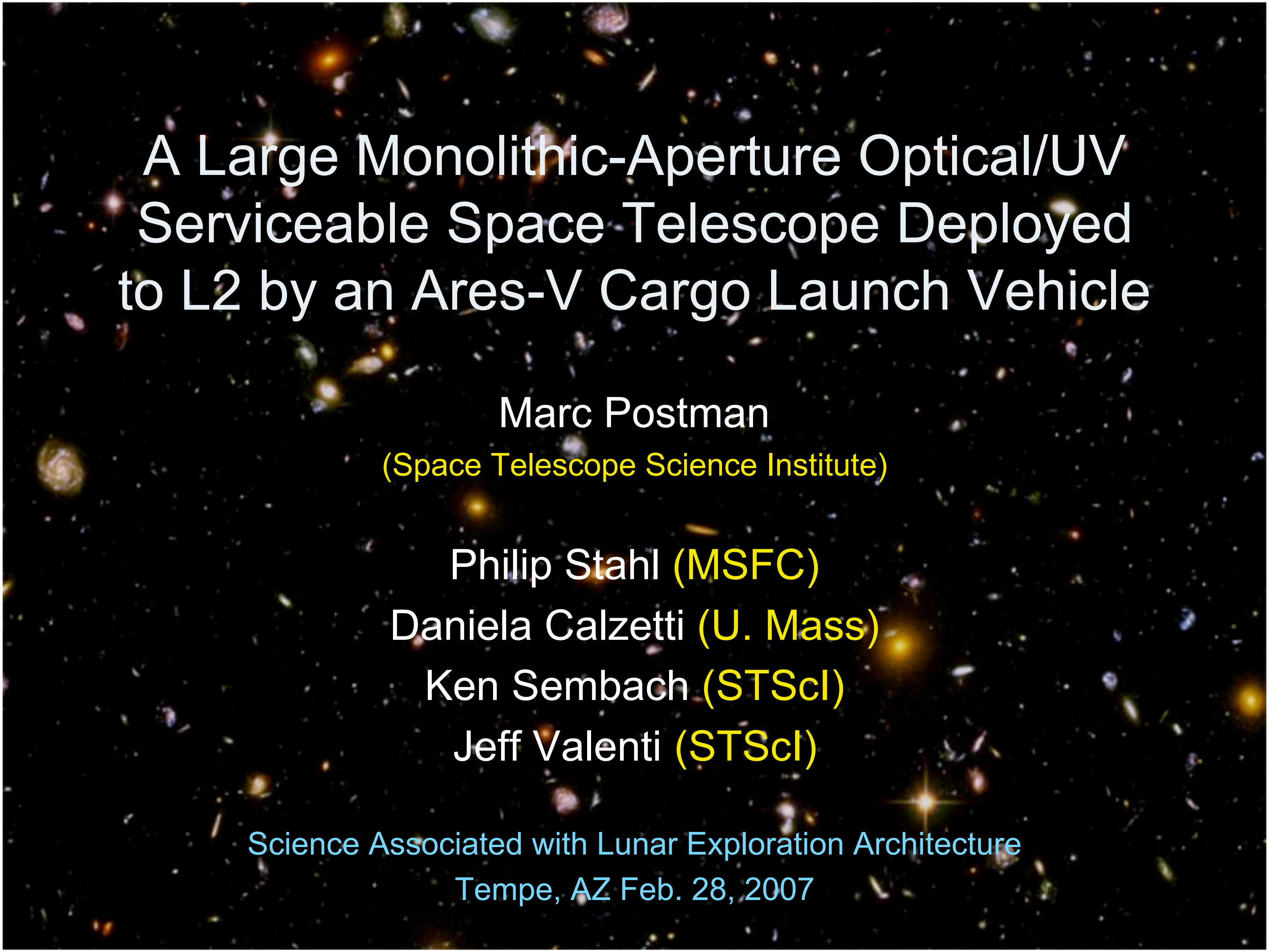
A Large Monolithic-Aperture Optical/UV Serviceable Space Telescope Deployed to L2 by an Ares-V Cargo Launch Vehicle
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Science Associated with Lunar Exploration Architecture
Tempe, AZ Feb. 28, 2007

Overview

What are the important topics in astrophysics for the next two decades?

What observational capabilities will these topics demand?

How can the VSE infrastructure enable astrophysical research via a large, serviceable telescope at L2?

Hot Topics in Astrophysics

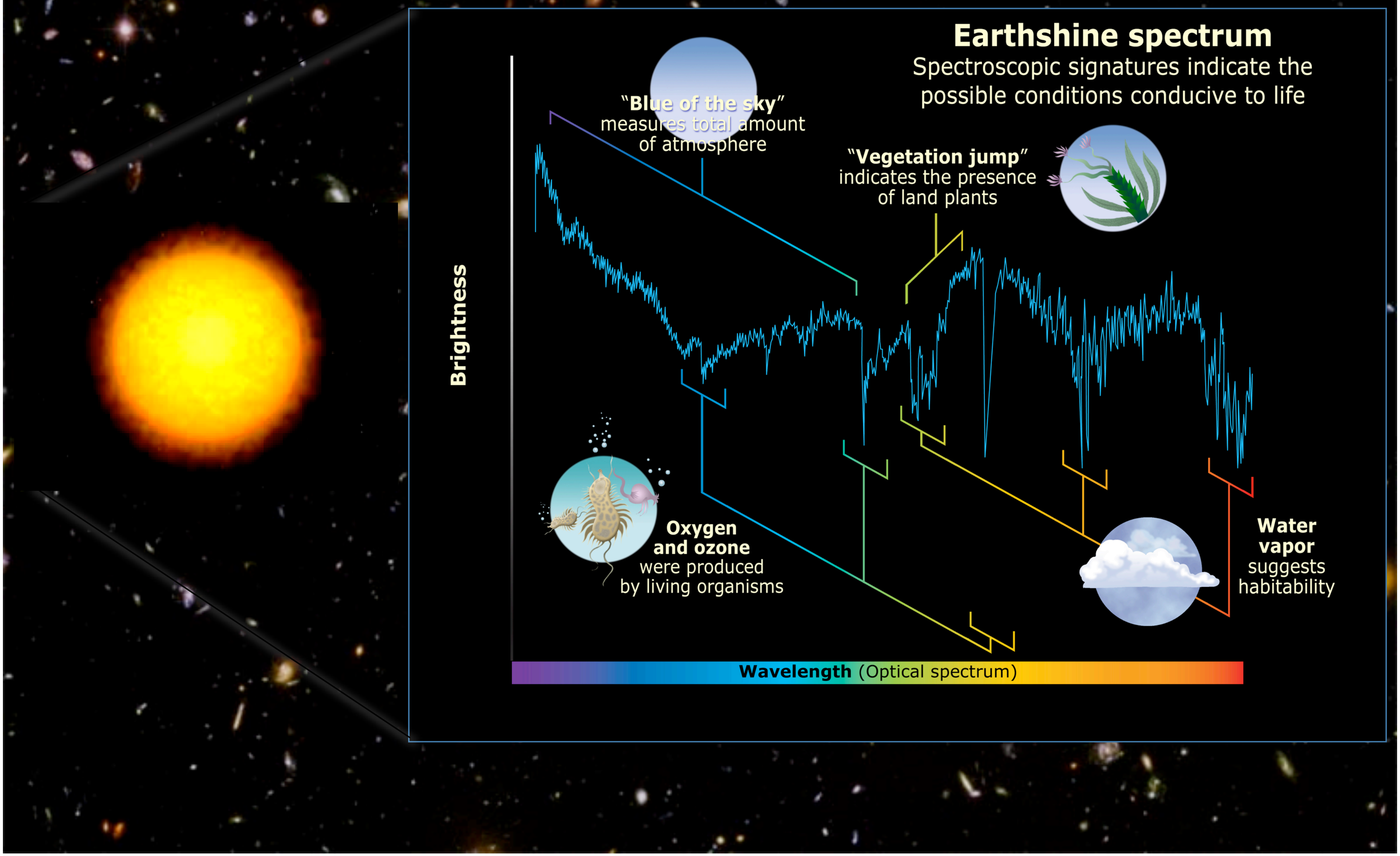
- How did the universe begin, how did it evolve from the soup of elementary particles into the structures seen today, and what is its destiny?
- How do galaxies form and evolve?
- How do stars form and evolve?
- How do planets form and evolve?
- Is there life elsewhere in the universe?

- Space-based telescopes have been and will continue to be essential tools for answering these fundamental questions about nature.
- Large telescopes, in particular, are required to observe larger volumes of space at ever finer resolution.

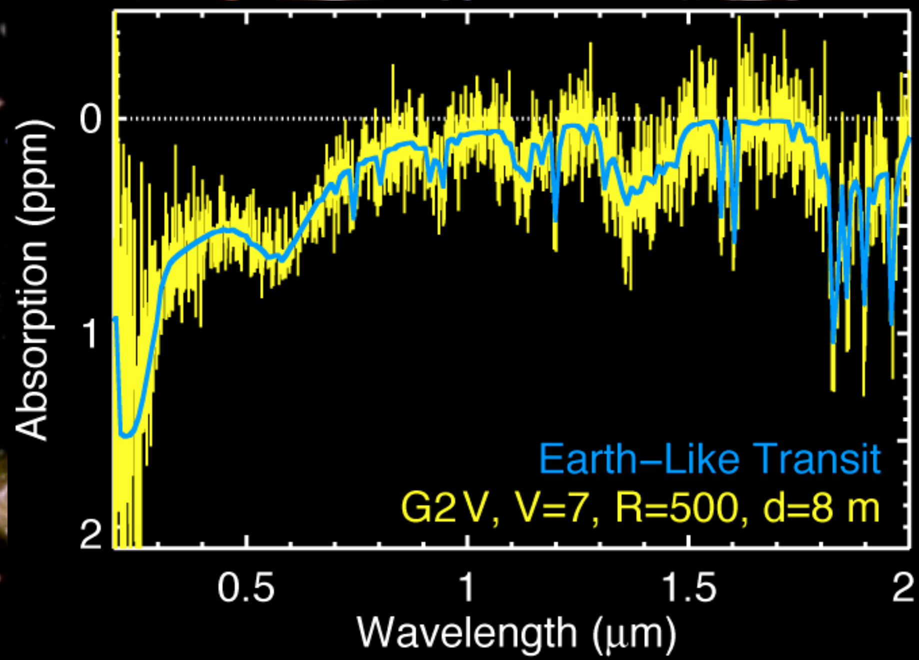
Why do we need a large (8 - 15m) optical/UV space telescope?

- Detect presence of dominant bio-signatures in terrestrial exoplanets (hi-contrast spectroscopy)
- Characterize the atmospheres of transiting exosolar planets up to 1000 light years away (ultra precision photometry)
- Measure the light from individual main sequence stars in hundreds of nearby large galaxies (hi-resolution imaging)
- Observe the UV light from warm baryonic matter - a key component of the universe that has yet to be mapped on large-scales (access UV wavelengths over wide-field)
- Provide hi-resolution imaging that is at least ~3x better than HST and 4x better than JWST. Complement large surveys done with JWST and ALMA.

Science case example: Looking for the faint trace of life

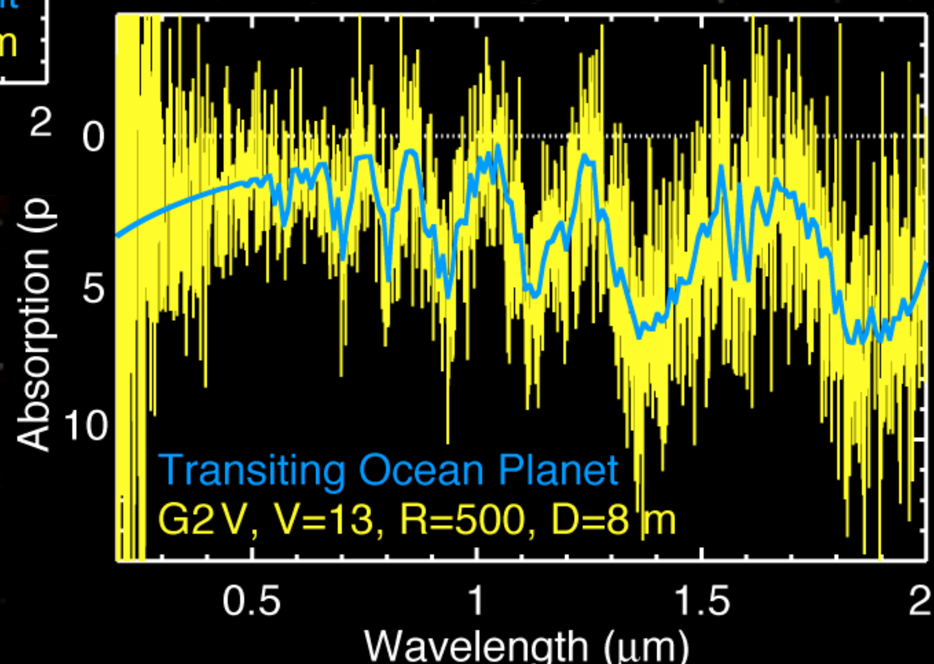


Science case example: Looking for the faint trace of life

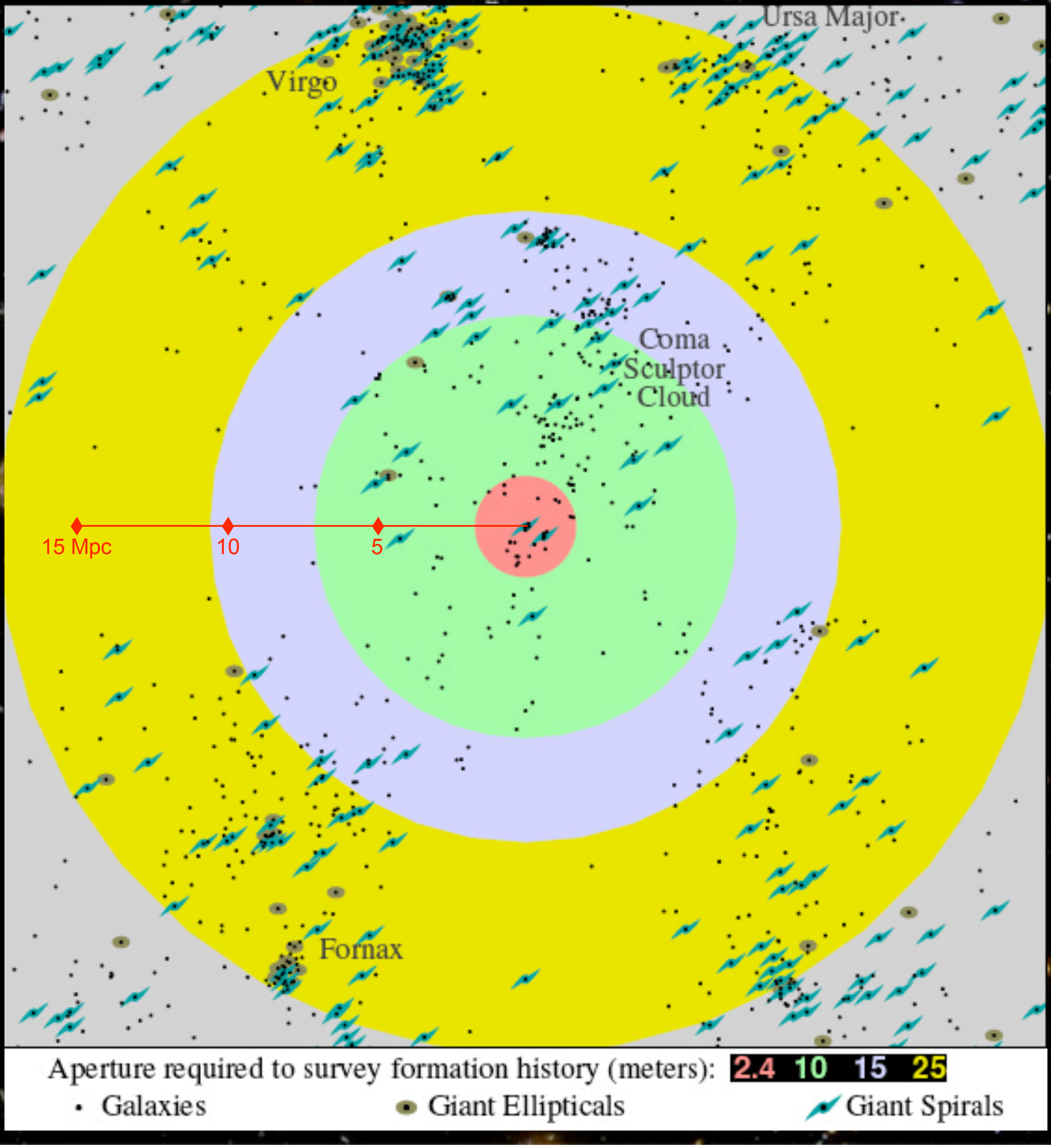


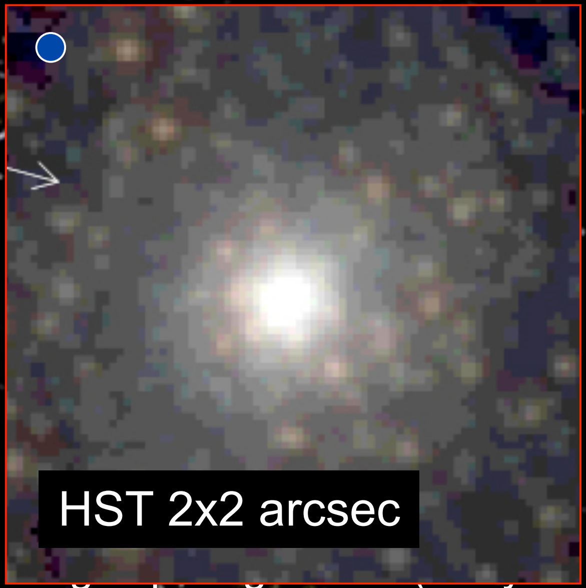
Below: Same exposure time as left except that planet spectrum is based on Ehrenreich et al. "Ocean" planet spectrum.

Above: Simulated 50 hour exposure, with 10 hours done during transit of earth-like planet and two 20 hour exposures before and after. Spectral Resolution = 500; Yields S/N ~ 5 (Valenti 2007 based on Ehrenreich et al. 2006 model)



Science case example: Understanding how stars form





Globular Cluster at 2.5 Mpc

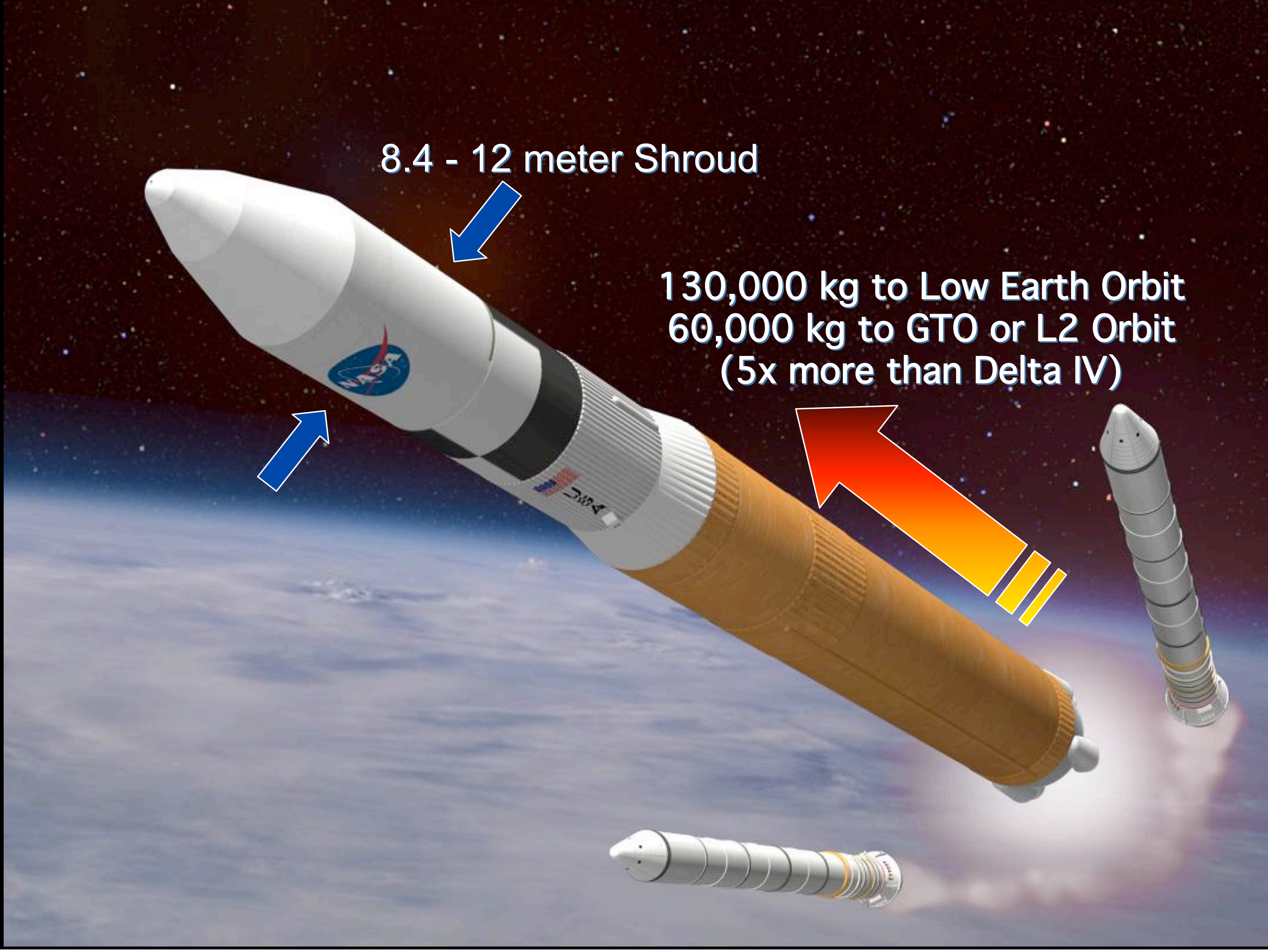
Capabilities of Free-flying Astronomical Spacecraft

Precise pointing and attitude control (<5 milli-arcsecs rms jitter)
All-sky access (large field of regard)
Wide-field diffraction-limited imaging
Excellent temperature stabilization (to a fraction of a degree K) at L2.
Efficient operations (near optimal on-target performance)
Servicing greatly extends mission value and life (e.g., HST)
Many of the capabilities once thought to require a stable surface are readily achieved in free space.
Need to select locale that achieves best science for lowest cost.

STScI Workshop in November: While the lunar surface enables some key astrophysical investigations, for the near-term, free-flying spacecraft can accomplish a broader range of astrophysics.

How Can the VSE Infrastructure Help?

Ares V Cargo Launch Vehicle



Proposal: Use Ares V to Deploy Large, monolithic-aperture Telescope to L2

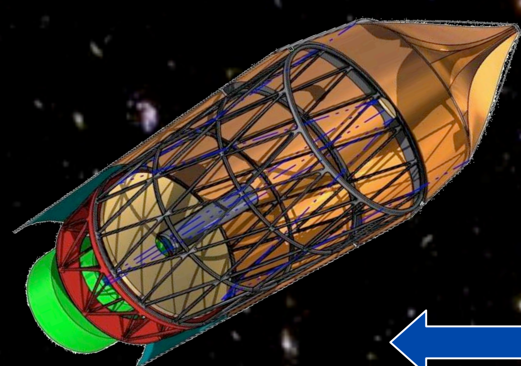
- Current Launch Vehicle Mass & Volume Constraints drive Mission Architecture & Performance:
  - Limited Aperture or Deployable Structure
    - TPF-C Asymmetric Aperture
    - SAFIR Deployable Segmented Telescope
  - Limited Mass or Extreme Light-weighting
    - Con-X Areal Density
- And, drive Mission Implementation Cost & Risk
- Ares V eliminates these limits and enables compelling science performed using a new class of mission architectures

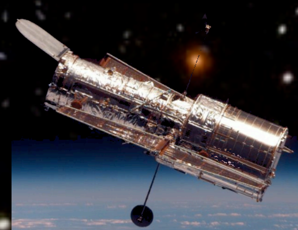
Design Concept

6 to 8 meter Monolithic Telescope with full baffle tube can fit inside the dynamic envelope of Ares V 8.4 to 12 meter shrouds. (Larger sizes if asym aperture is used)

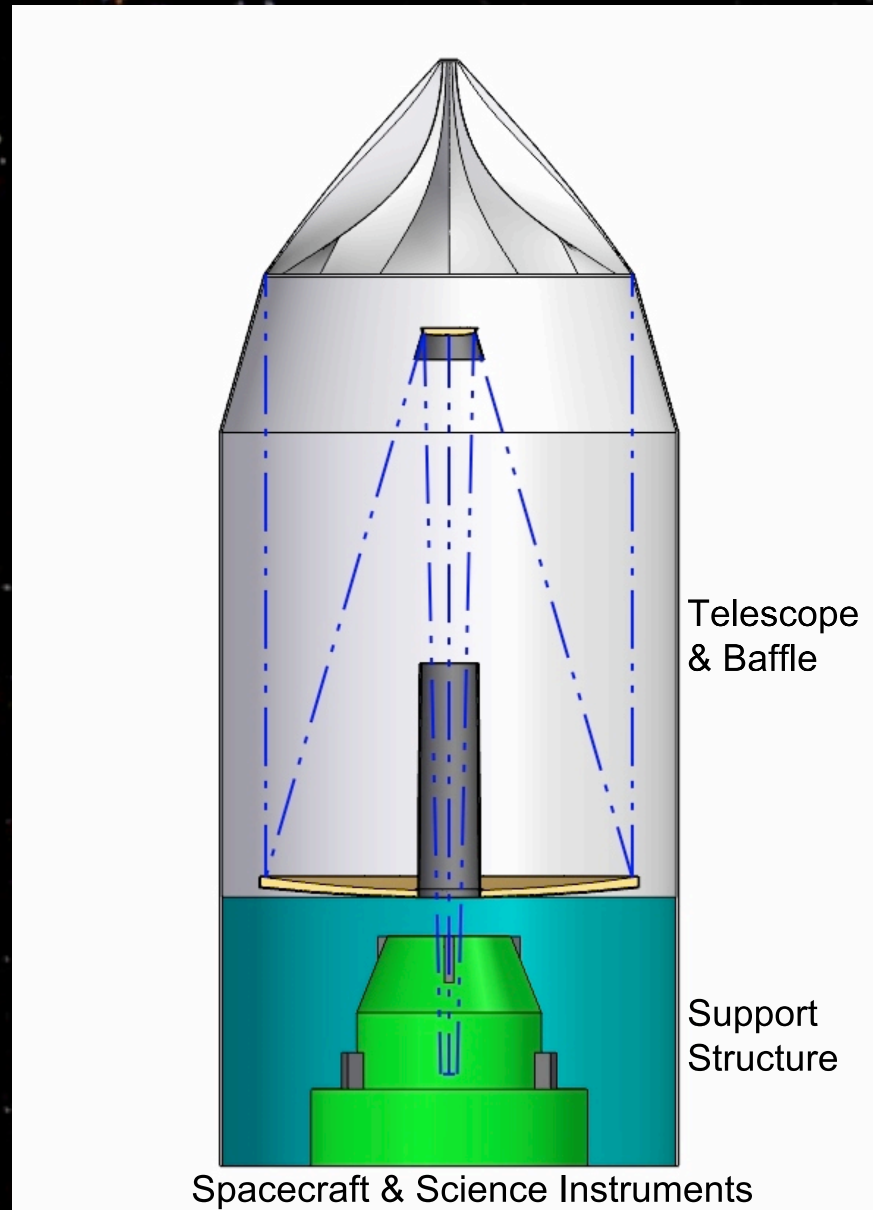
Reduce Cost (& Risk) by using existing ground-based telescope mirror technology.

8.4 m primary mirror (7 existing)
23,000 kg (6m ~13,000 kg)
$20M (JWST PM cost ~$100M)
~8 nm rms surface figure (TPF spec)





HST to scale



20 - 25 year Mission Life

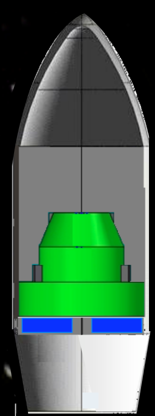
Design the observatory to be serviceable

Replace Science Instruments every 3-5 yrs (or possibly longer)

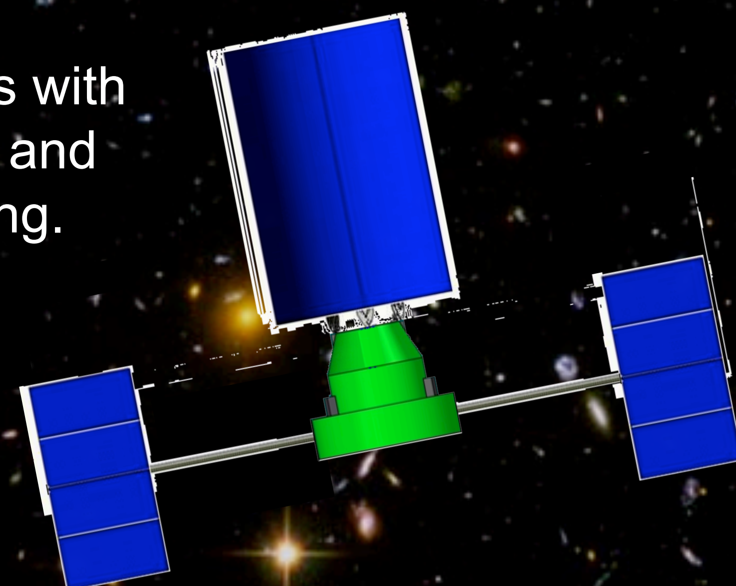
Replacement
Spacecraft in ELV

(Ares V not required)

Autonomously Docks to Observatory.
Replaces Science Instruments and
ALL Serviceable Components.



Observatory has split bus with
on-board attitude control and
propulsion during servicing.



Copy Ground Observatory Model – L2 Virtual Mountain

Summary

Compelling science case can be made to Decadal Review Committee for 6 - 8m class optical/UV space telescope; Need to begin assembling community team to do just this.

Ares V mass & volume capabilities enable entirely new mission architectures that would be compatible with the above facility, as well as other types of telescopes (x-ray, FIR, etc.)

Conceptual design study (Stahl et al. - next talk) indicates deploying monolithic UV/Optical Observatory is achievable

Possible new paradigm for future astrophysics missions - competitions for new instruments for space observatory rather than for new independent spacecraft

Primary technical challenges are autonomous rendezvous & docking for servicing - but large optical/UV space telescope can be scientifically justified even as a “one shot” mission.