The Story of Life in the Universe: The LUVOIR Mission Concept

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AbSciCon Bellevue, WA



What is **LUVOIR?**

Large UV / Optical / Infrared Surveyor (LUVOIR)

A space telescope concept in tradition of Hubble

- Far-UV to Near-IR bandpass
- Suite of imagers and spectrographs
- Serviceable and upgradable
- Time allocation following Hubble model: guest observerdriven

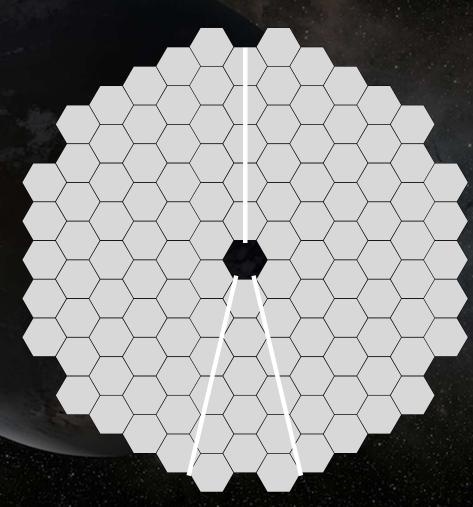
LUVOIR-A

15-m, on-axis telescope

- 120 segments, 1.223-m flat-to-flat
- 155 m² collecting area

Four instruments

- Extreme Coronagraph for Living Planetary Systems (ECLIPS)
- LUVOIR UV Multi-object Spectrograph (LUMOS)
- High Definition Imager (HDI)
- Pollux (CNES-contributed instrument design)



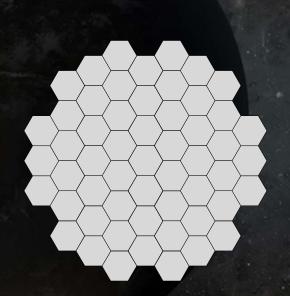
LUVOIR-B

8-m, off-axis telescope

- 55 segments, 0.955-m flat-to-flat
- 43.4 m² collecting area

Three instruments

- Extreme Coronagraph for Living Planetary Systems (ECLIPS)
- LUVOIR UV Multi-object
 Spectrograph (LUMOS)
- High Definition Imager (HDI)



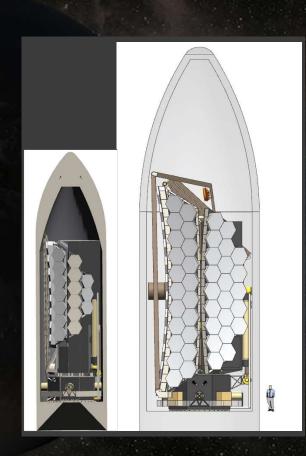
The LUVOIR Mission

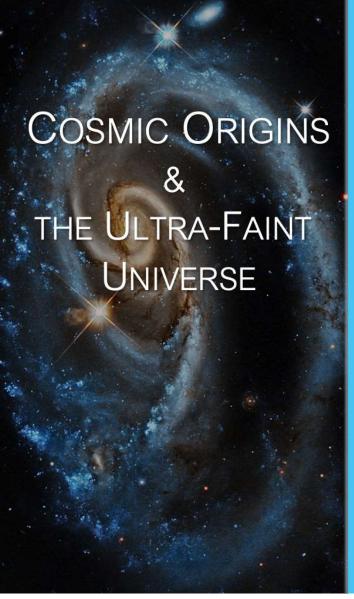
Launch in 2039 aboard an SLS Block 1B/2

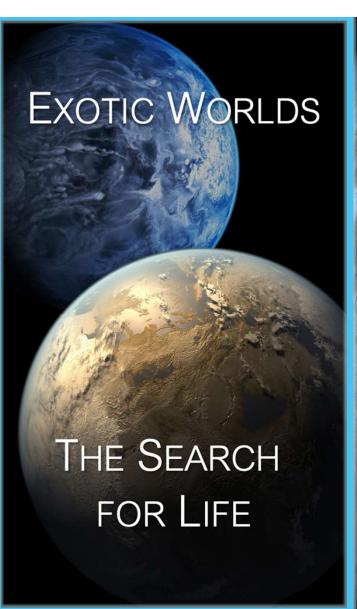
 SpaceX Starship and Blue Origin New Glenn are viable alternatives

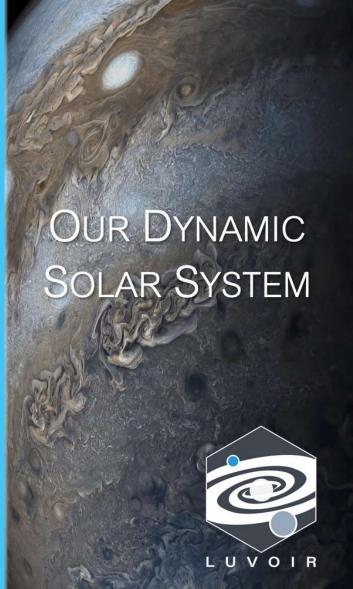
5-year primary mission, designed to be serviceable for a 25+ year lifetime

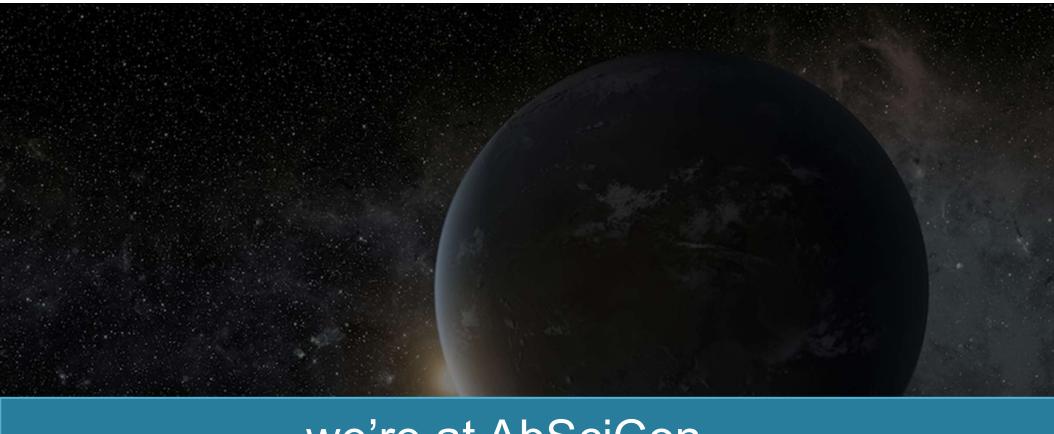
Operate in Sun-Earth L2 orbit









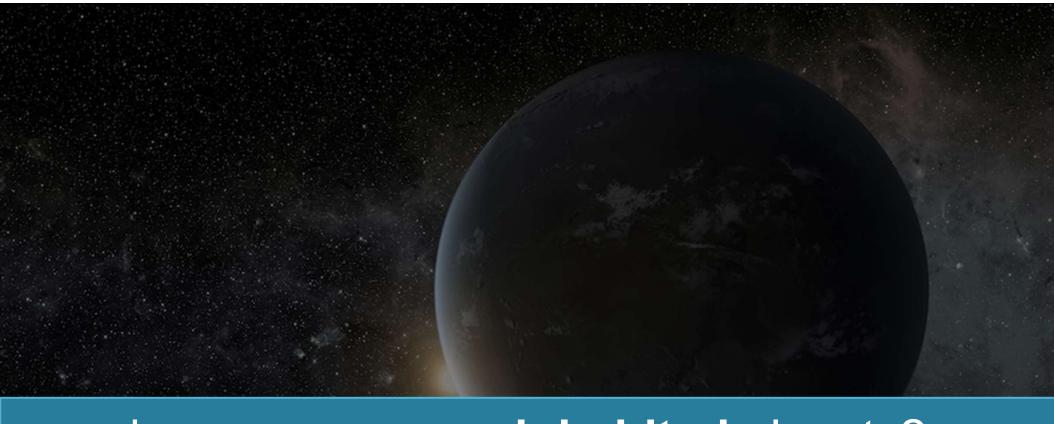


we're at AbSciCon...

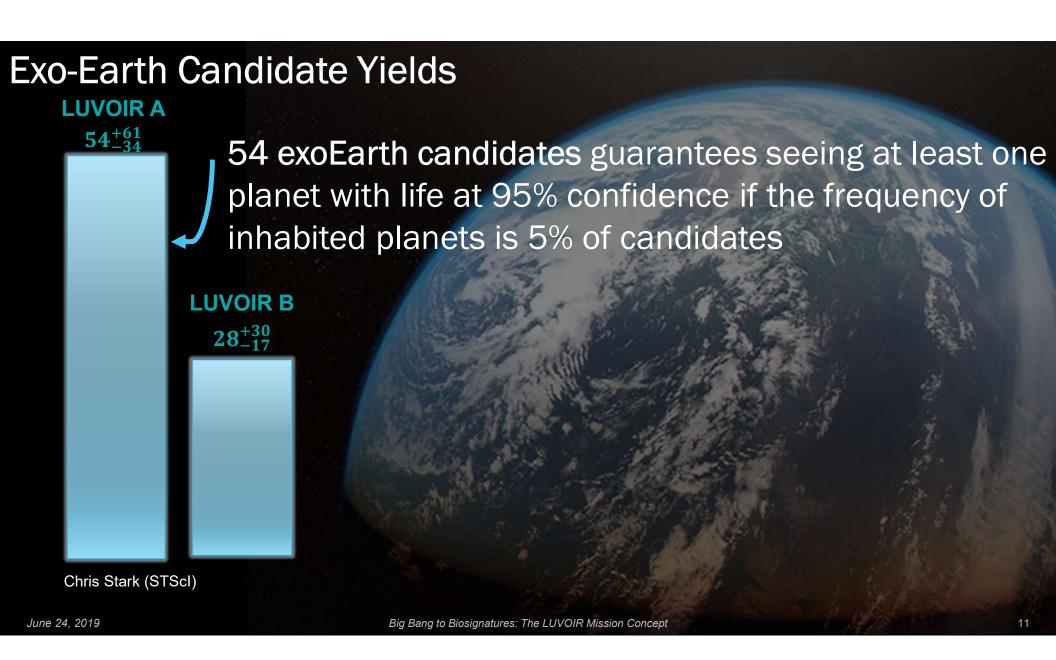


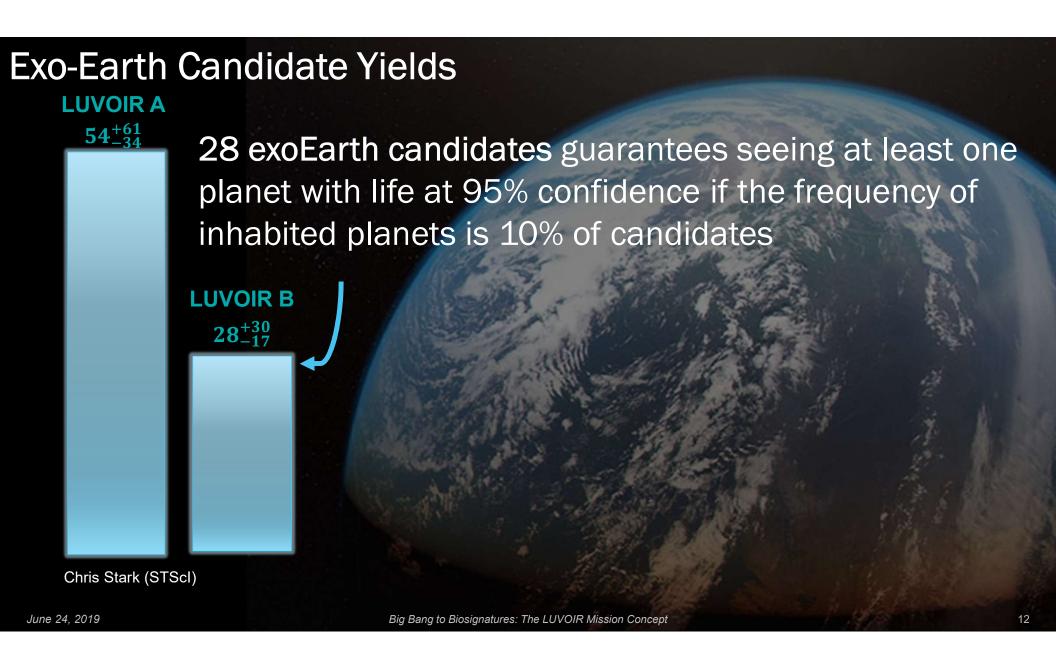


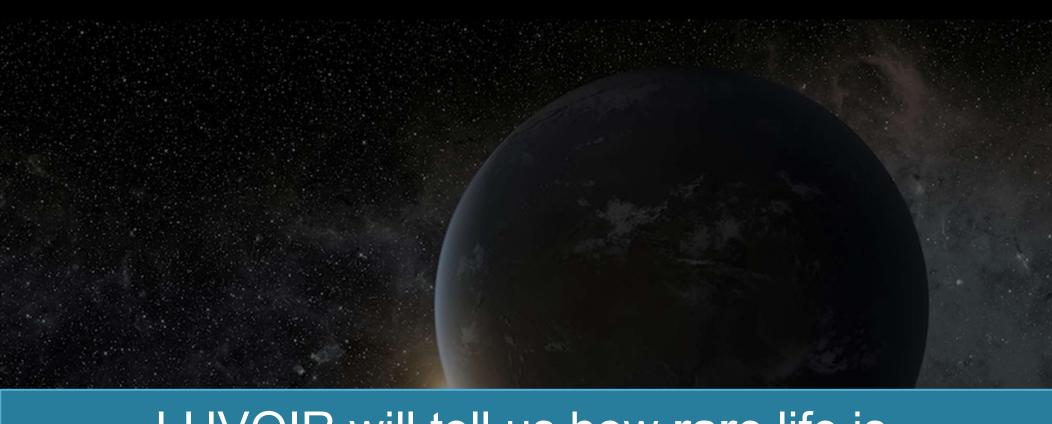
how common are habitable planets?



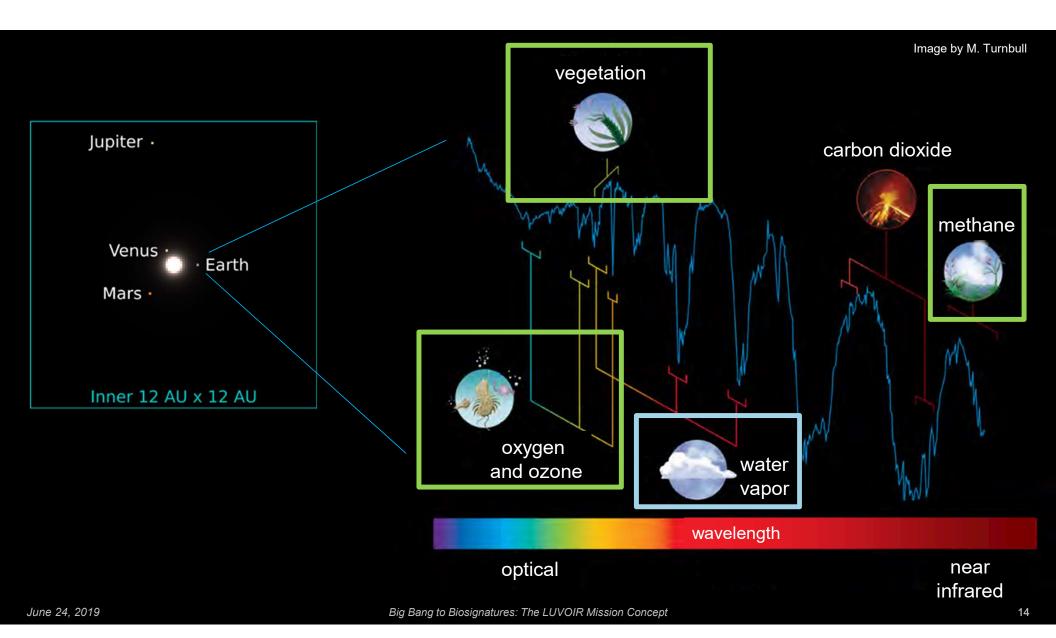
how common are inhabited planets?

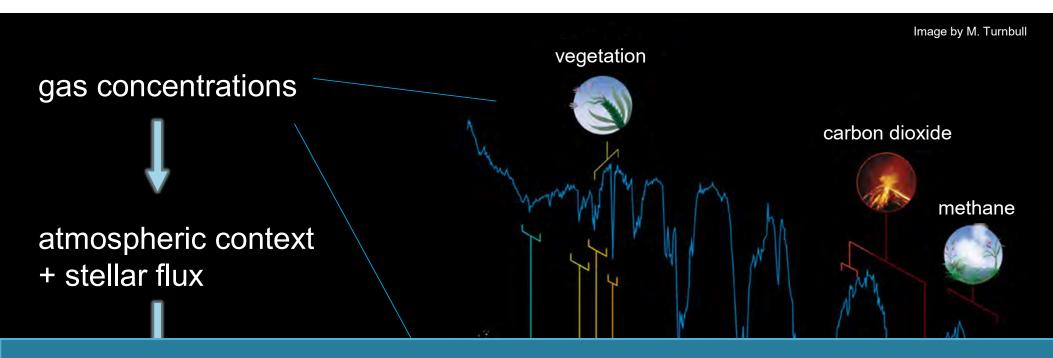






LUVOIR will tell us how rare life is.





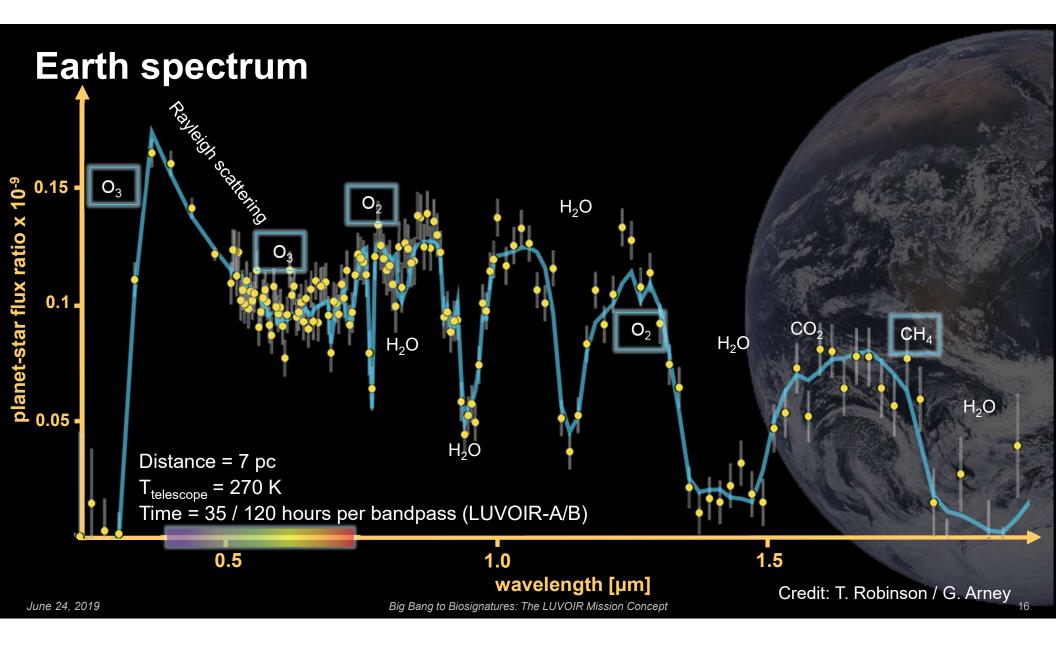
production rates that cannot be explained by abiotic processes point to biology

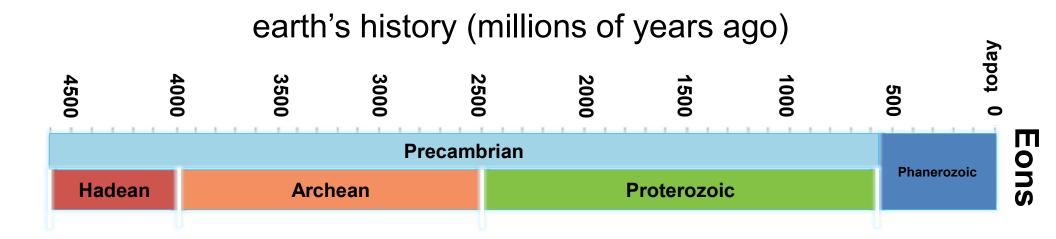
optical

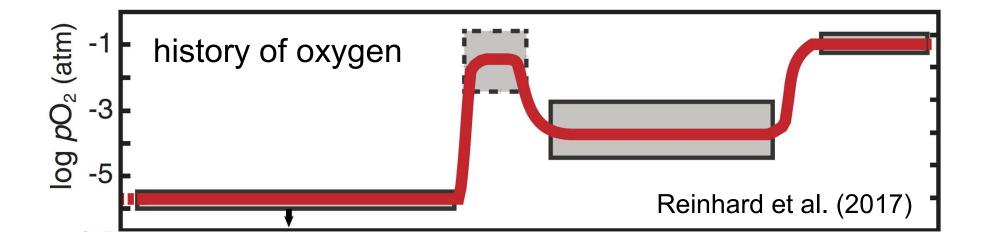
gas production rates

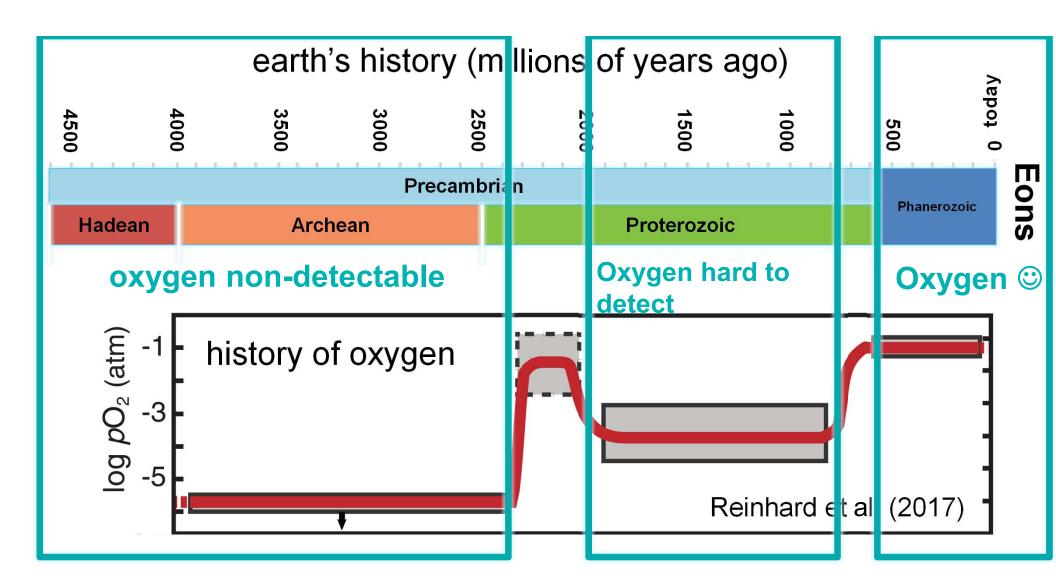
wavelength

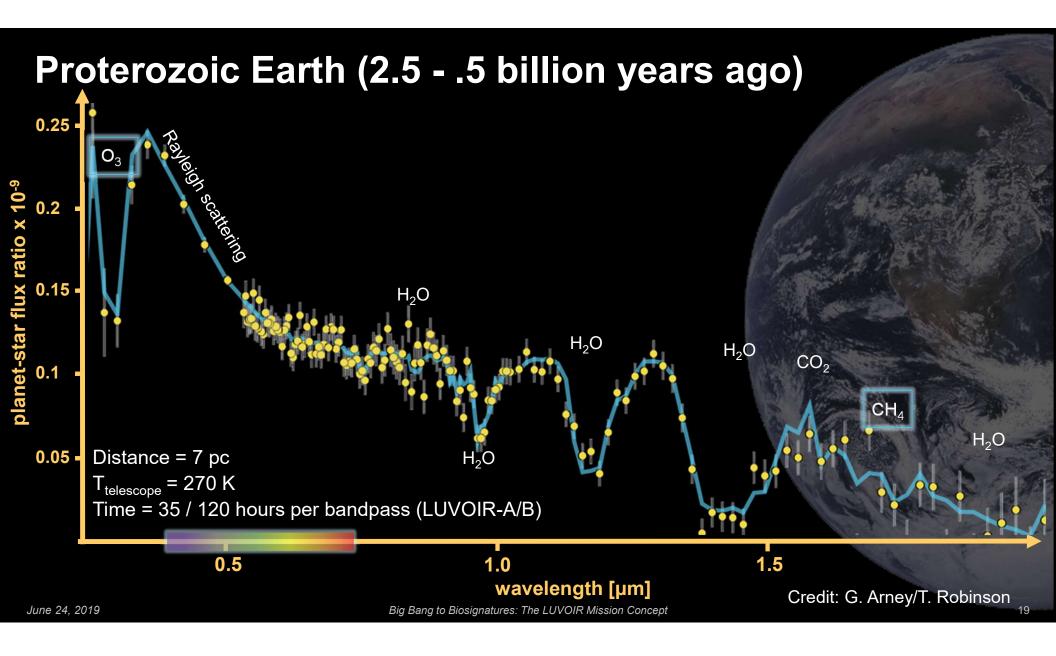
near infrared

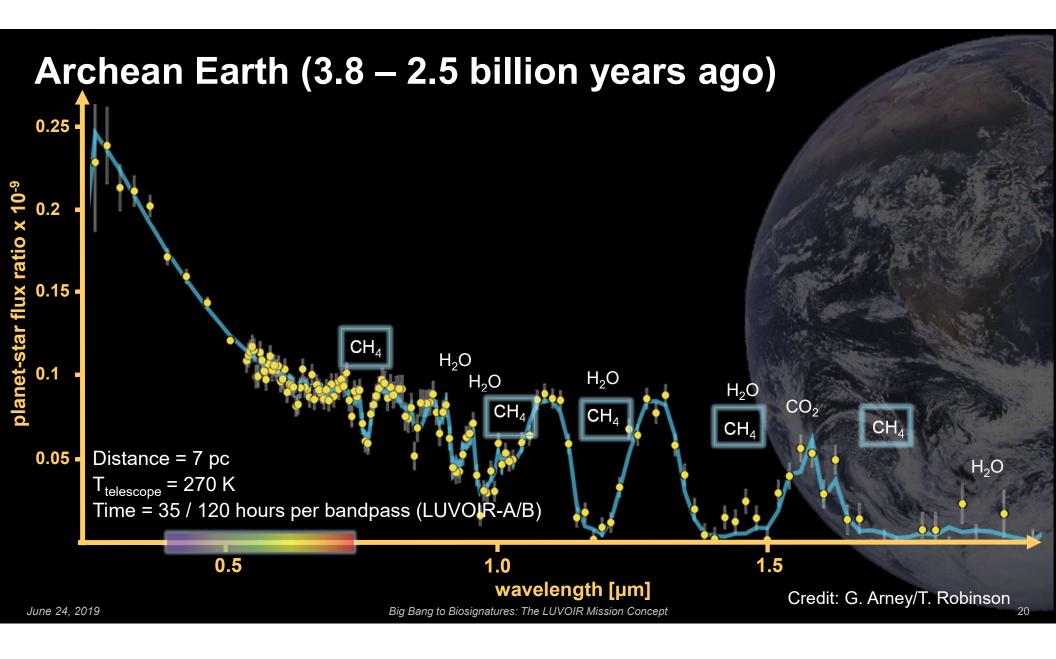


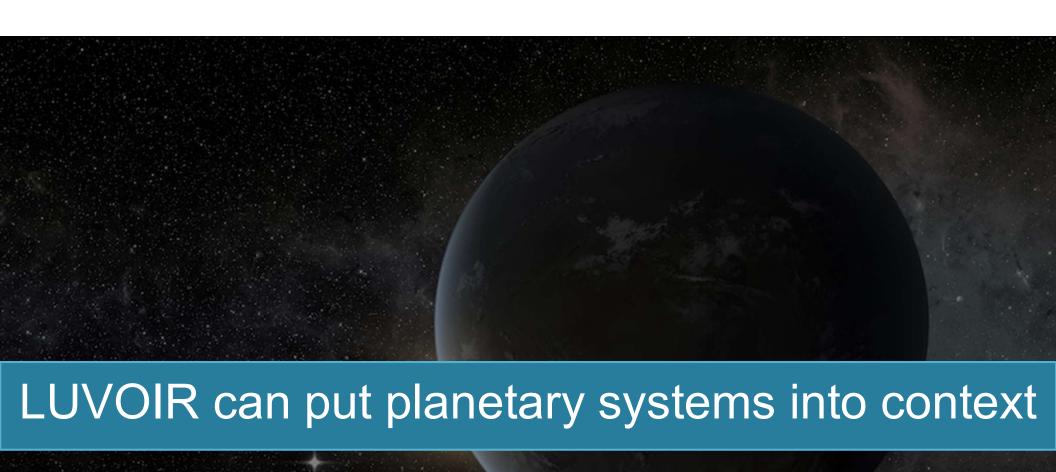




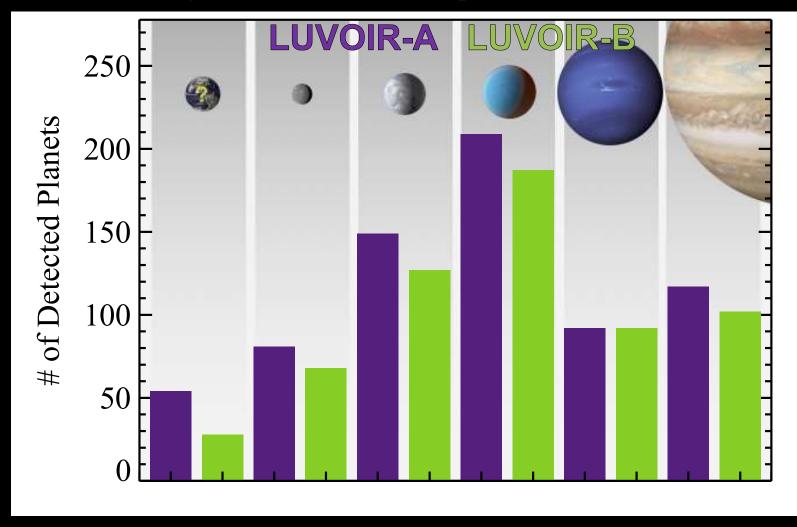




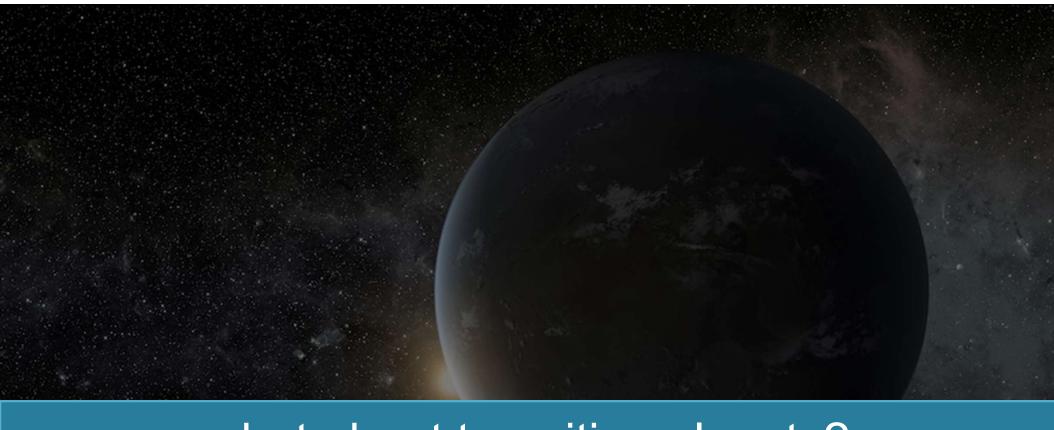




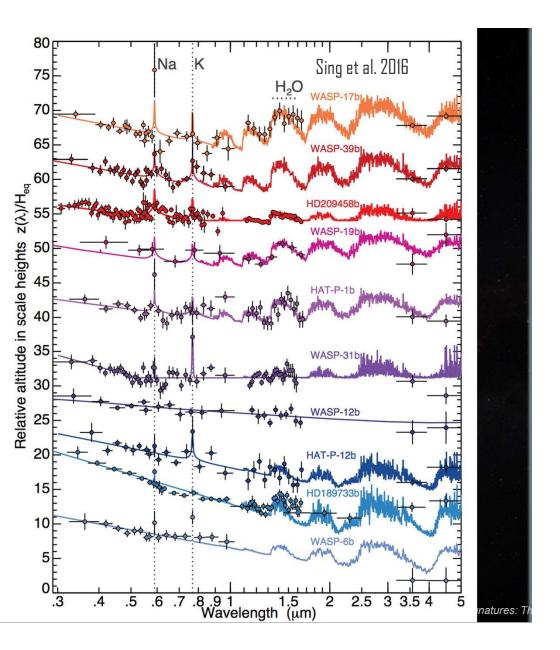
Imagine knowing the full diversity of worlds...

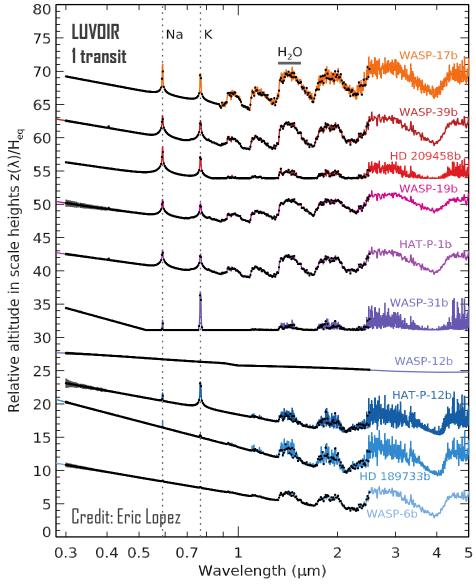


Credit: C Stark



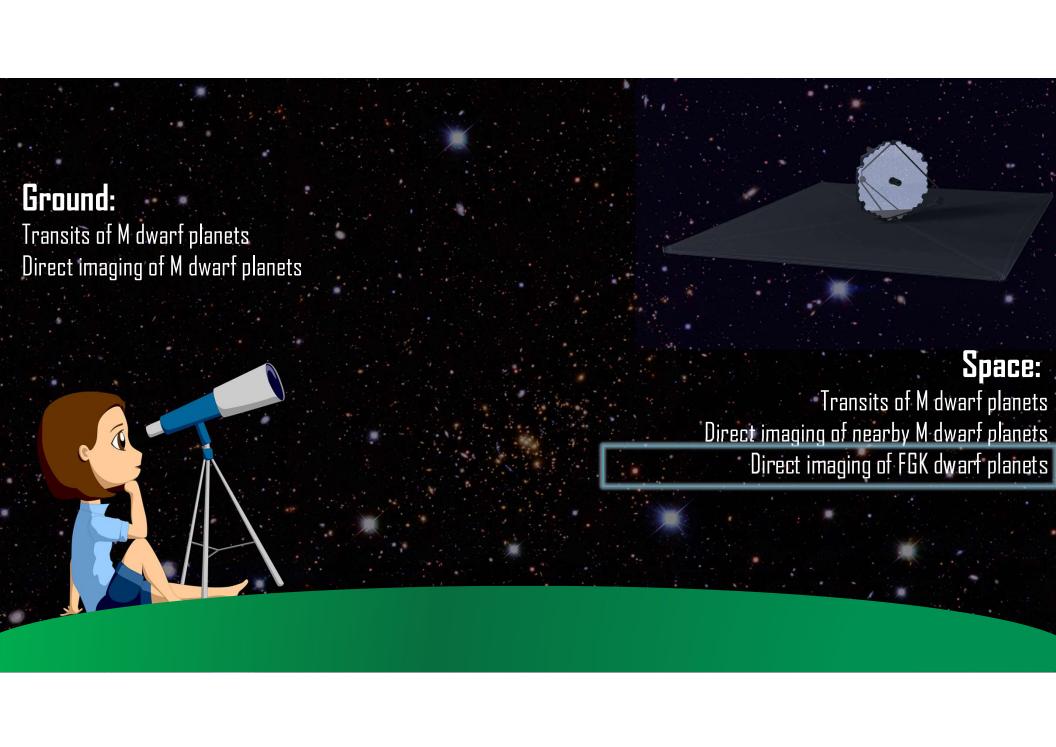
what about transiting planets?







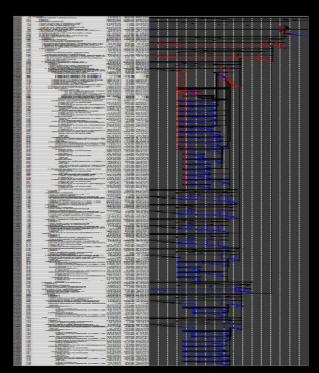
can you do this from the ground?



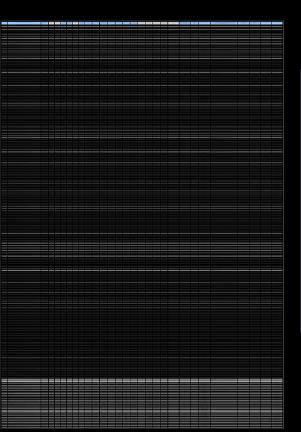


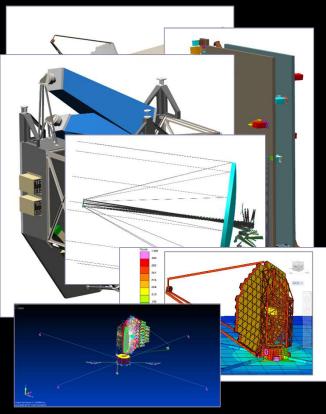
okay, but is this actually feasible?

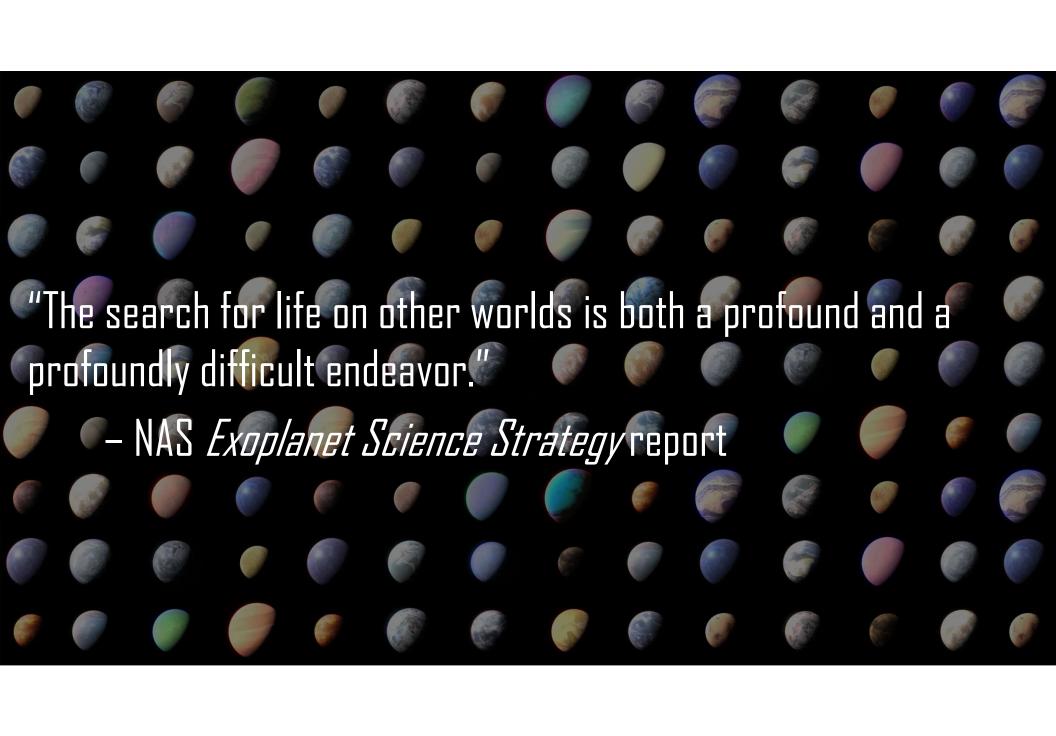
No previous strategic missions submitted to a Decadal Survey have been studied in as much detail



Mission Implementation Schedule



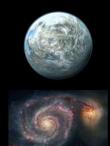




Backup Slides

Two Teams, One Vision Statement by the LUVOIR & HabEx STDTS

• The HabEx and LUVOIR (and Lynx and Origins) Science and Technology Definition Teams have devoted over three years and many thousands of person-hours to studying future large strategic space mission concepts.



- Together, HabEx and LUVOIR will present eleven different architectures.
- The HabEx and LUVOIR teams have collaborated since their initiation, and as a result are offering a 'buffet' of options, with corresponding flexibility in budgeting and phasing.
- The studies agree that a joint astrophysics exoplanet UV/optical/near-IR space observatory provides a bold, compelling, and achievable vision for space astronomy.



Total astrometric program time for exoEarth masses to within 25%:

LUVOIR-A: 24 days

LUVOIR-B: 43 days

constrain masses



The ECLIPS coronagraph

Observational challenge

Faint planets next to bright stars

Solution

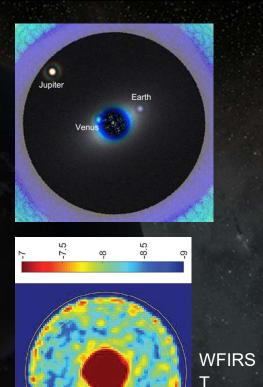
Extreme Coronagraph for Living Planet Systems (ECLIPS)

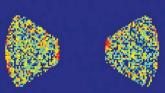
Coronagraph with contrast < 10⁻¹⁰

Imaging spectroscopy (R = 70-200)

Bandpass: 0.2 µm to 2.0 µm

Tech development via WFIRST coronagraph





WFIRS T SPC

HLC

The LUMOS instrument

Observational challenge

Spatially-resolved spectra of gases in many different environments, solar system targets in the UV

Solution

LUVOIR UV Multi-Object Spectrograph (LUMOS)

R = 500 - 63,000

Bandpass: 100 nm to 900 nm

FOV: 2' x 2' with 0.07" x 0.14" slitlets

FUV imaging channel

Heritage from STIS, COS, & NIRSPEC





HST STIS UV instrument

The HDI instrument

Observational challenge

Imaging the ultra faint and very small at high resolution. Long-term imaging of objects in the outer solar system.

Solution

High-Definition Imager (HDI)

2 x 3 arcmin field-of-view

Bandpass: 0.2 µm to 2.5 µm

Nyquist sampled

Micro-arcsec astrometry capability (planet masses, etc)

Heritage from HST WFC3 & WFIRST



HST Wide Field Camera 3

POLLUX: a European contribution to the LUVOIR mission study

POLLUX is a concept for a UV spectro-polarimeter with high resolution point-source capability (R $\sim 10^5$)

Complementary to the LUMOS instrument

To be defined & designed by a consortium of 10 European institutions, with leadership/support from CNES

The conceptual study conducted by CNES could serve as a support for a future ESA contribution

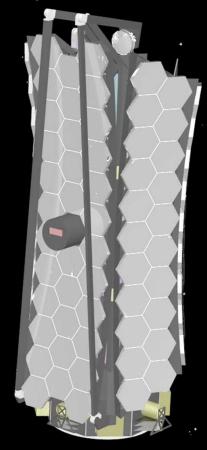
Is this technologically feasible?

WFIRST has achieved 10⁹ contrast in coronagraph testbeds

"Coronagraph technologies have significantly evolved over the past 10 years such that the challenge of designing and building a coronagraph that is insensitive to segmented/obscured apertures and low-order wavefront errors has largely been overcome."

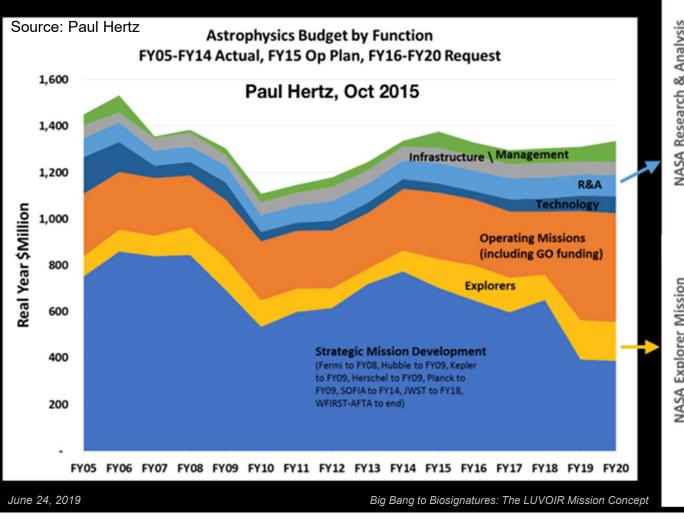
NAS Exoplanet Science Strategy Report

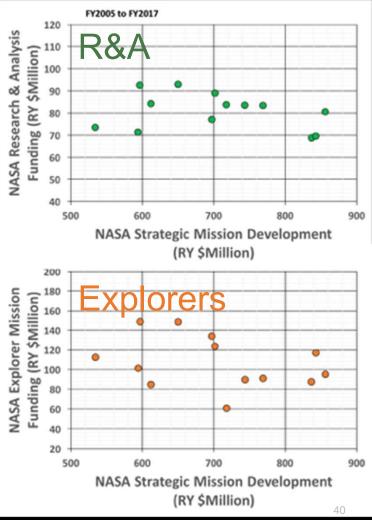
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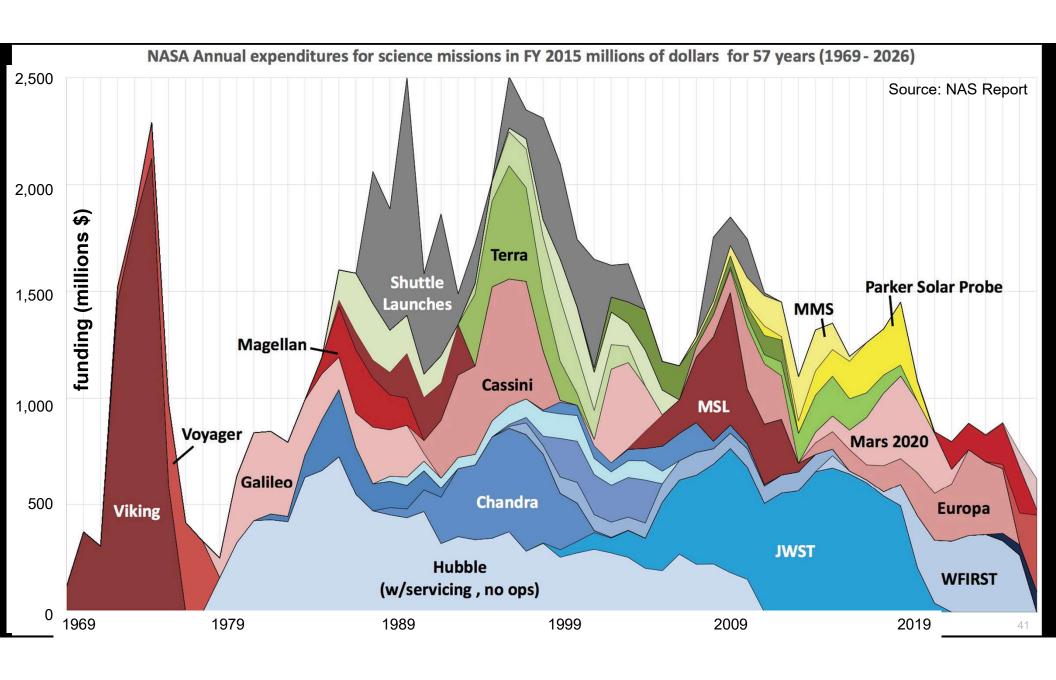


Deployment of large segmented telescope to be demonstrated by JWST

Is all of this affordable?







LUVOIR online simulation tools https://luvoir.stsci.edu



Performance Simulation

This page links to performance simulations and visualizations for the LUVOIR mission, NASA's future concept observatory for UVOIR astronomy.

All these widgets are experimental. If they are not working, email tumlinson AT stsci.

HDI Photometric ETC

This is the basic ETC for photometry in multiband images.

LUMOS Spectroscopic ETC

This is a very simple ETC for UV spectroscopy with LUVOIR.

Galaxy Imaging Resolution

A comparison of resolutions for a z = 2 galaxy.

UV MOS and Stellar Clusters

See the impact of UV MOS on the study of stellar clusters and their feedback.

ExoEarth Atmospheres

Play around with atmosphere spectra for exoEarths of different surface composition.

Coropagraphic Spectra of Varied Exoplanets

Model observations of Earth-like planets with realistic noise.

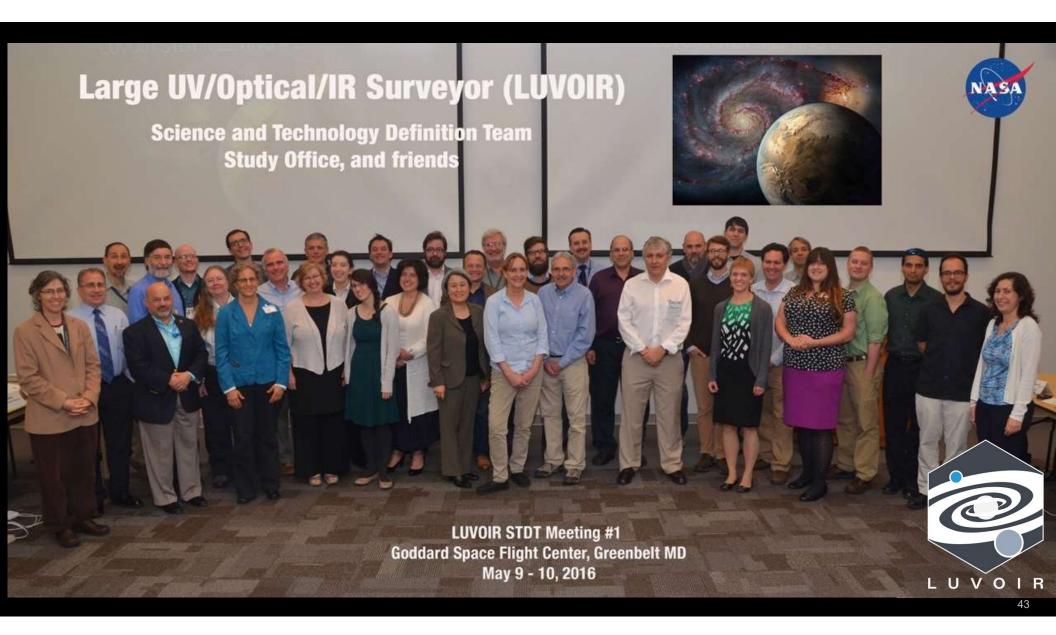
Exoplanet Yield Tool

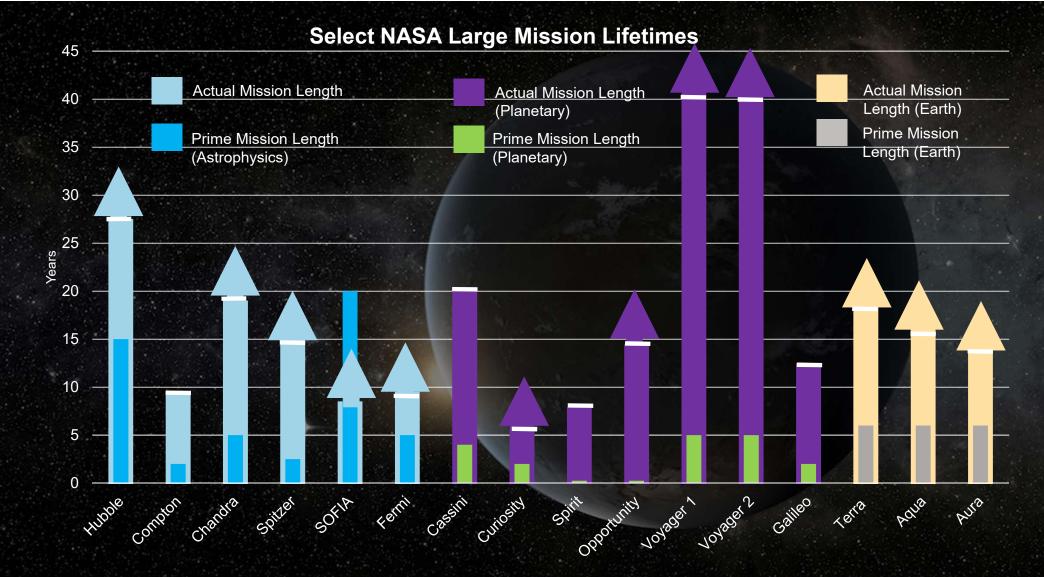
A widget for visualizing the Stark et al. ExoEarth yields.

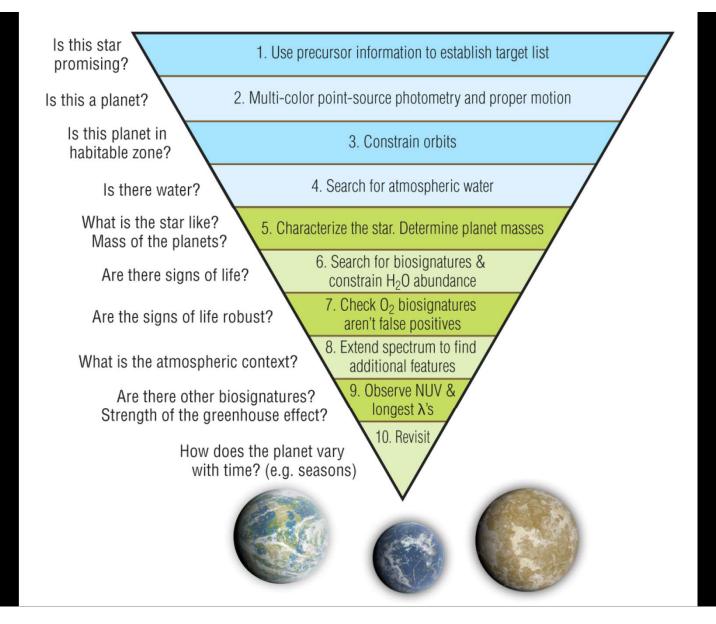
Multiplanet Yield Tool

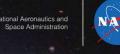
An experimental rendering of the Stark et al. multiplanet yields.

Learn More about LLIVOIE











LUVOIR Large UV/Optical/IR Surveyor

The Large UV/Optical/IR Surveyor (LUVOIR) is a concept for a highly capable, multi-wavelength space observatory with ambitious science goals. This mission would enable great leaps forward in a broad range of science, from the epoch of reionization, through galaxy formation and evolution, star and planet formation, to solar system remote sensing. LUVOIR also has the major goal of characterizing a wide range of exoplanets, including those that might be habitable - or even inhabited.

> Learn more at asd.gsfc.nasa.gov/luvoir

COSMIC ORIGINS THE ULTRA-FAINT UNIVERSE



OUR DYNAMIC SOLAR SYSTEM

