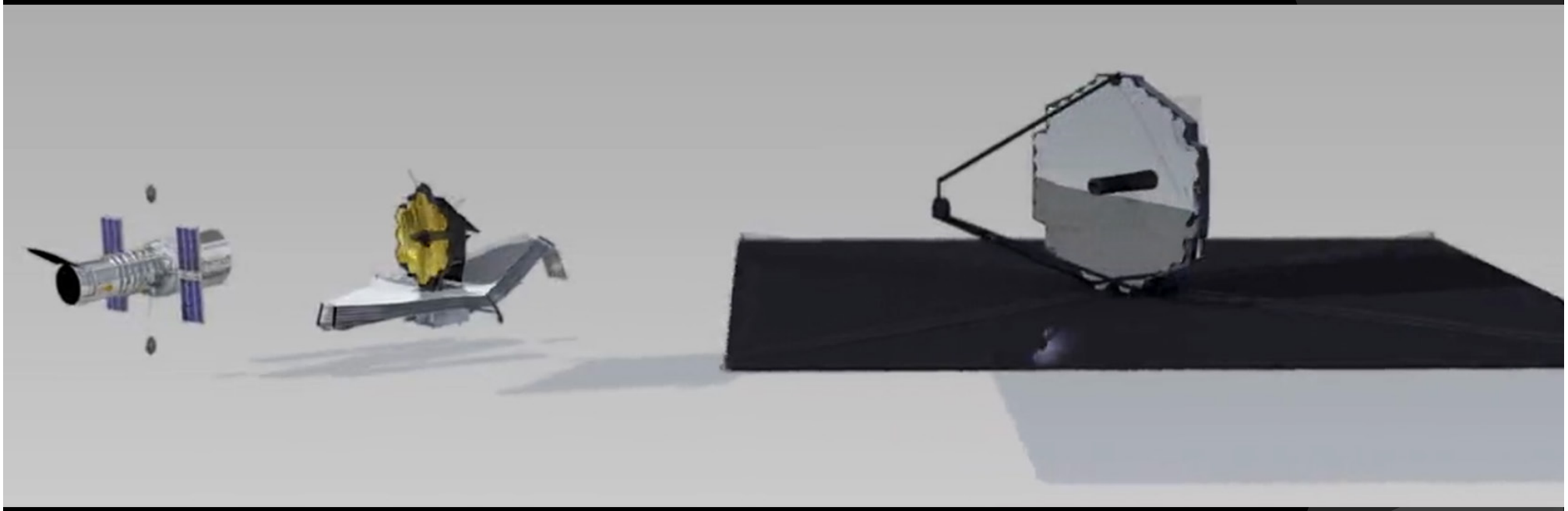
LUVOIR計画への参加

(Large UV/Optical/Infrared Surveyor)



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2019/9/25, 光赤天連シンポジウム@三鷹

Telescope

Segmented, deployable UV/optical/ near-IR telescope

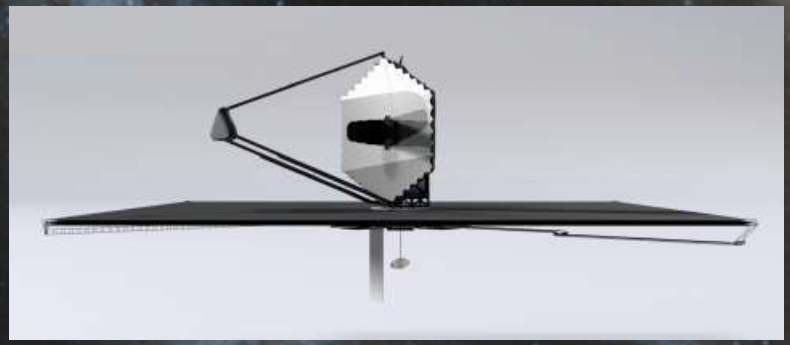
Ultra-stable to enable high performance coronagraphy

Serviceable and upgradable (25 year lifetime goal for non-serviceable components)

Earth-Sun L2 orbit

Two sizes to be studied :

- LUVOIR-A : 15 m diameter, for launch in an SLS or equivalent
- LUVOIR-B 8 m diameter, for launch in a Delta IV Heavy or equivalent



Candidate Instruments

ECLIPS: Coronagraph with imaging spectroscopy

- Total bandpass: 200 – 2200 nm
- 10^{-10} contrast — Imaging
- IWA - OWA: ~ 4 - 64 λ/D — IFS

LUMOS: Multi-object spectrograph and imager

- Total bandpass: 100 – 400 nm
- Resolution: 500 < R < 65,000

HDI: High resolution wide-field camera

- Total bandpass: 200 – 2500 nm
- Field-of-view: 2’ x 3’ — UVIS:3Gpix NIR:320Mpix

POLLUX: Spectropolarimeter (European instrument)

- Total bandpass: 100 – 400 nm
- R = 120,000
- Circular + linear polarization

concepts

LUVOIR A
15m
On-axis
4 instruments

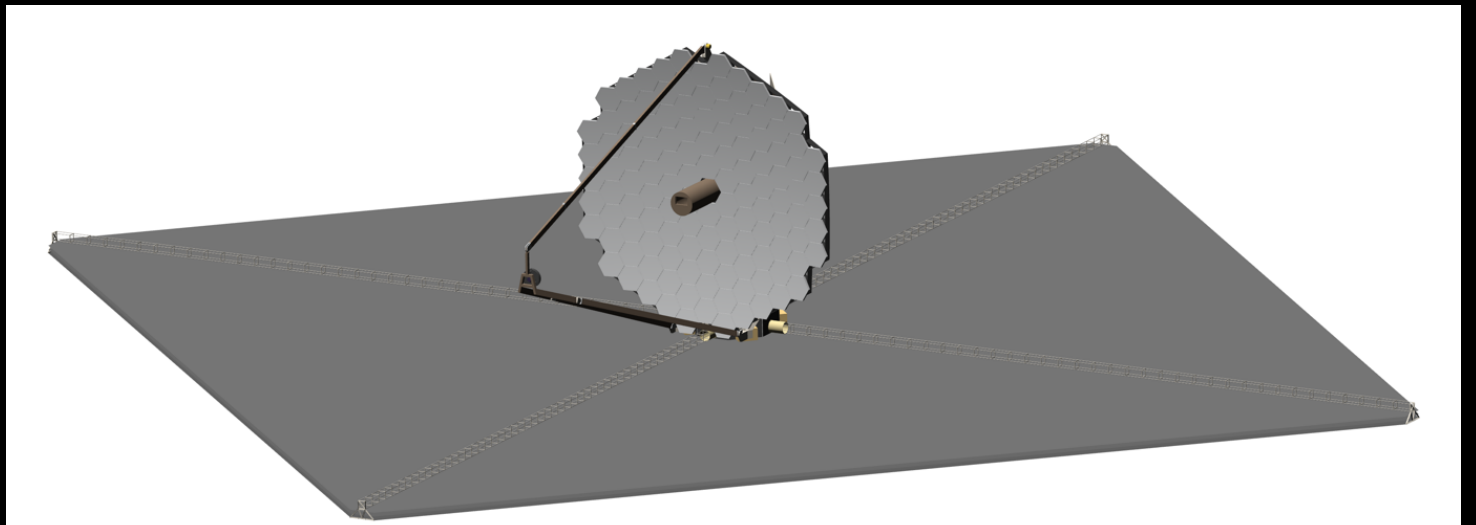


Figure 4: *The LUVOIR-A observatory, with a 15-m diameter on-axis primary mirror and four instruments. Deployment and pointing animation at https://asd.gsfc.nasa.gov/luvoir/design/. Credit: A. Jones (NASA GSFC)*

LUVOIR B
8m
Off-axis
3 instruments

Far-UV to near-IR bandpass (100 nm to 2500 nm)

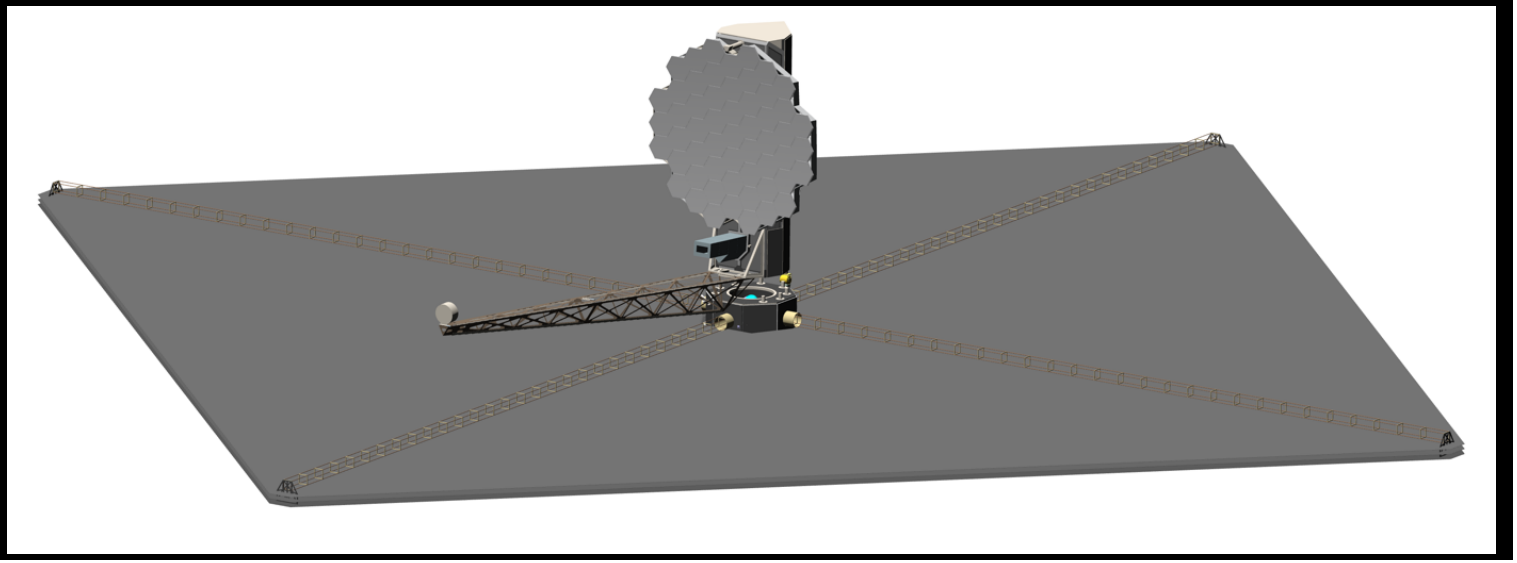


Figure 5: *The LUVOIR-B observatory, with an 8-m diameter off-axis primary mirror and three instruments. Deployment and pointing animation at https://asd.gsfc.nasa.gov/luvoir/design/. Credit: A. Jones (NASA GSFC)*

Main objectives

- **Habitable exoplanets & biosignatures**
  - To know habitability, we must measure the molecular constituents of Earth-size planets around Sun-like stars. demands analysing light from the planets themselves via direct spectra.
  - Measuring the frequency of Earth-like conditions on rocky worlds requires surveying hundreds of stars to find dozens of candidate exoplanets. strong driver of telescope aperture.

- **Broad range of general astrophysics**
  - **the births and deaths of galaxies**

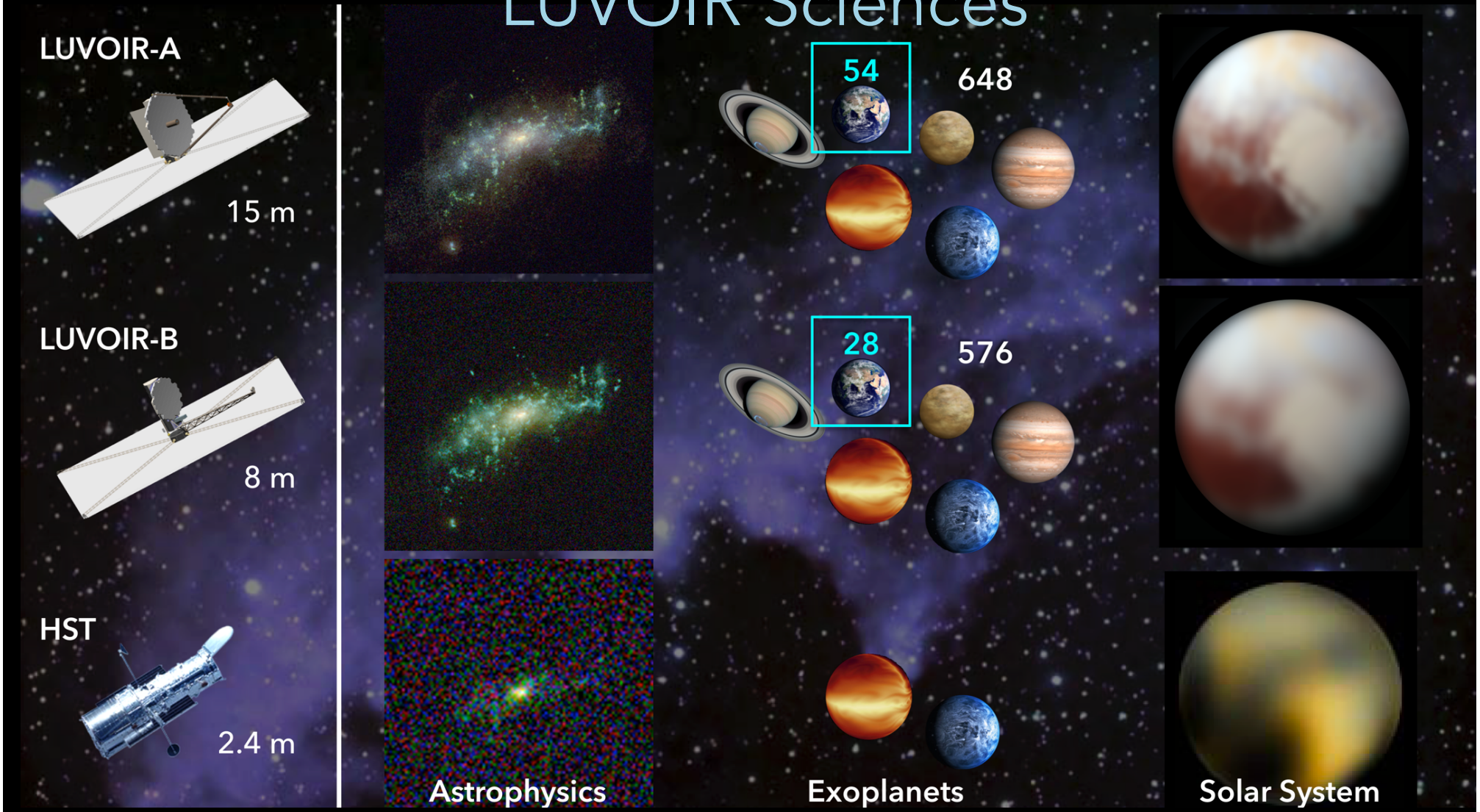
  Cycling of matter to, from and within galaxies can be studied by UV spectroscopy, as the gas flows are hot and tenuous.

  Illuminate mergers in forming massive galaxies by deep, high-resolution imaging of all types of galaxies down to the smallest building block across cosmic time.

  - **monitoring the solar system**

  Search for life in icy moon. By high-resolution UV spectral imaging of icy moons can reveal the currently unknown strength and frequency of geyser activity.

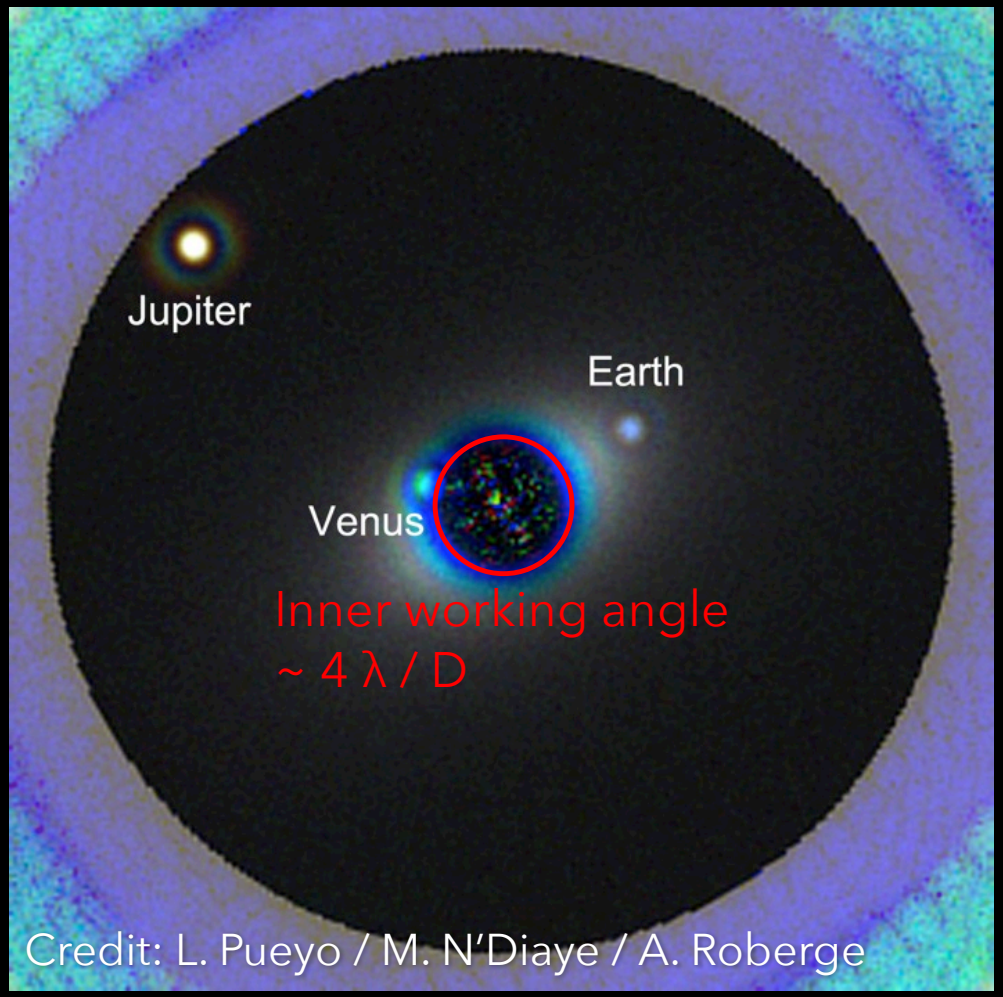
LUVOIR Sciences



- Resolve faint stars and galaxies for galaxy formation.
- Detect 54 (15m) & 28 (8m) Earth-like planets that can be probed for signs of life.
- Near-flyby quality observation of Solar system bodies.

Characterizing Earth 2.0 …

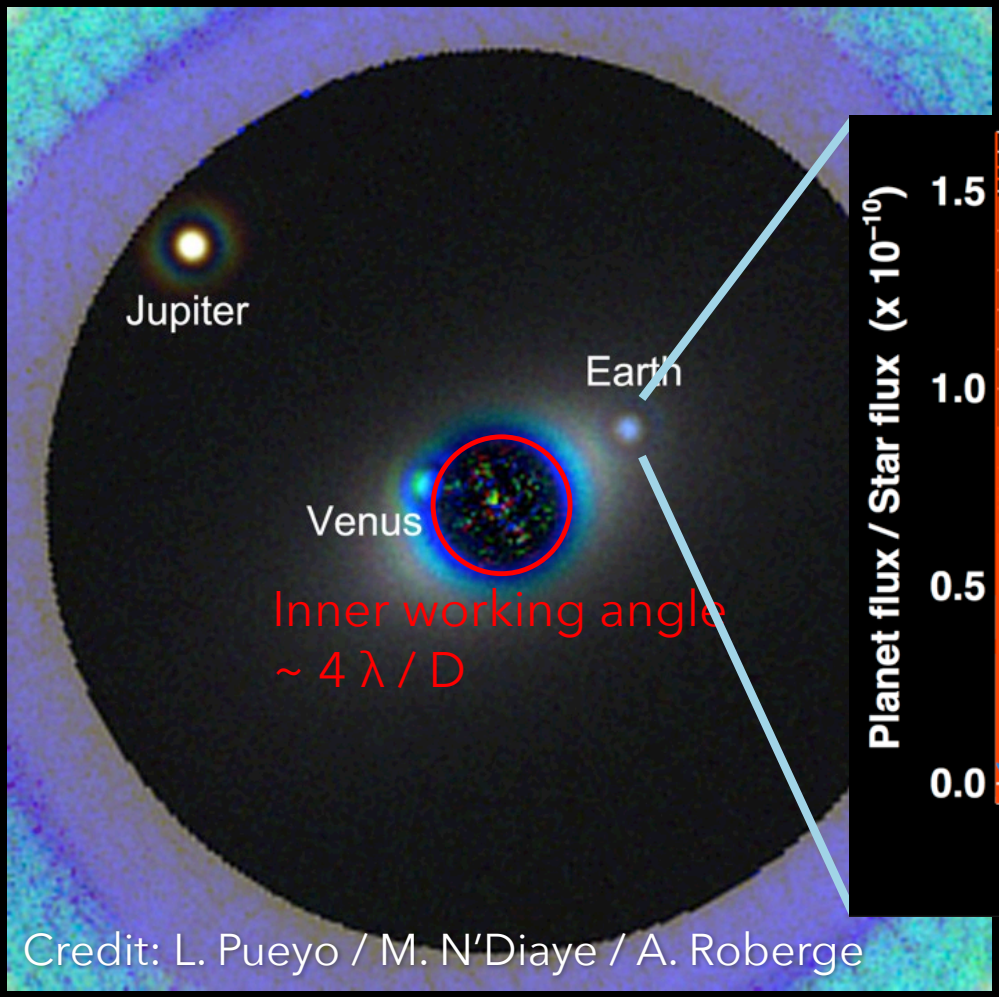
Solar System from 13 parsec
with coronagraph and 12-m telescope



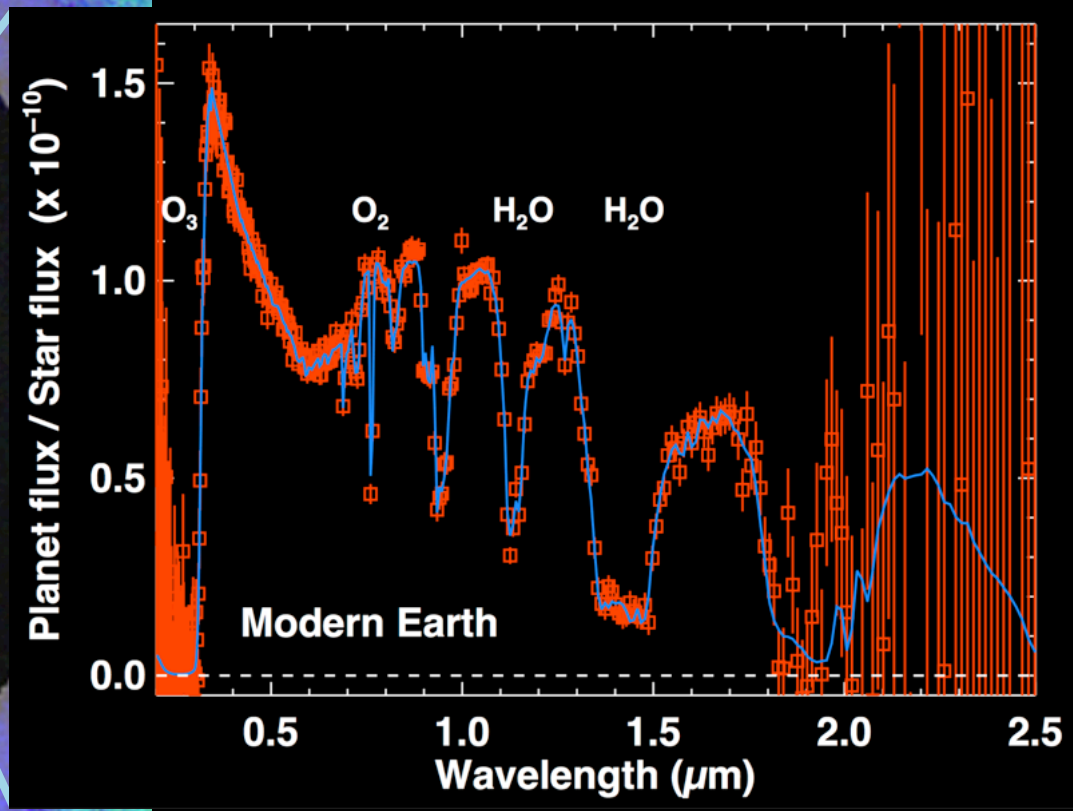
Characterizing Earth 2.0 …

Solar System from 13 parsec
with coronagraph and 12-m telescope

Distance = 10 pc
$D_{telescope}$ = 12-m
R = 150
Time = 96 hrs per band

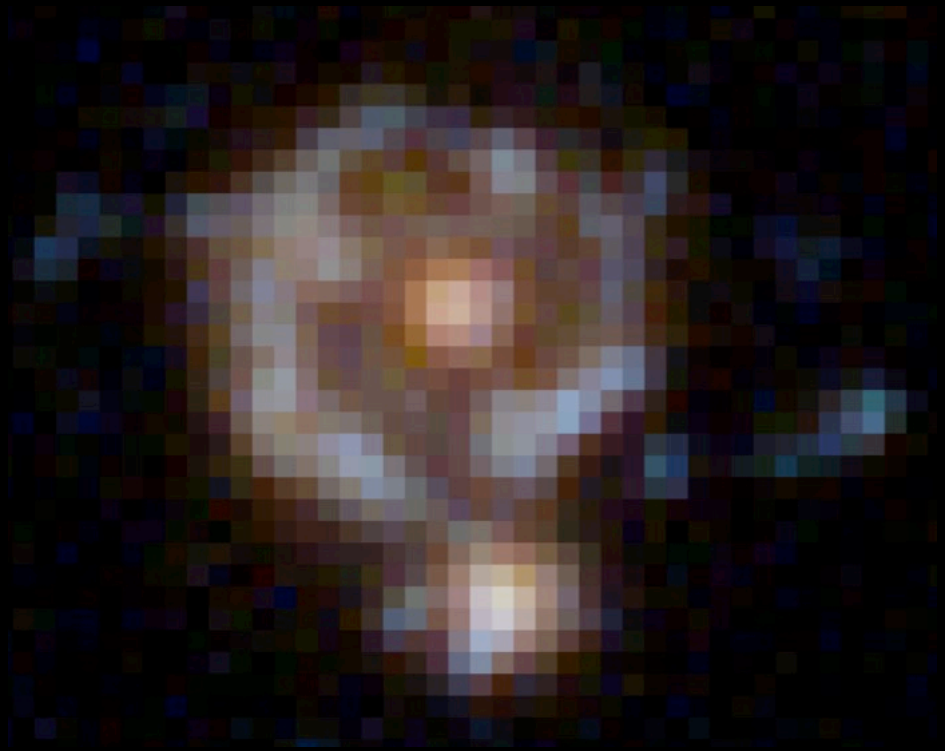


Credit: L. Pueyo / M. N'Diaye / A. Roberge

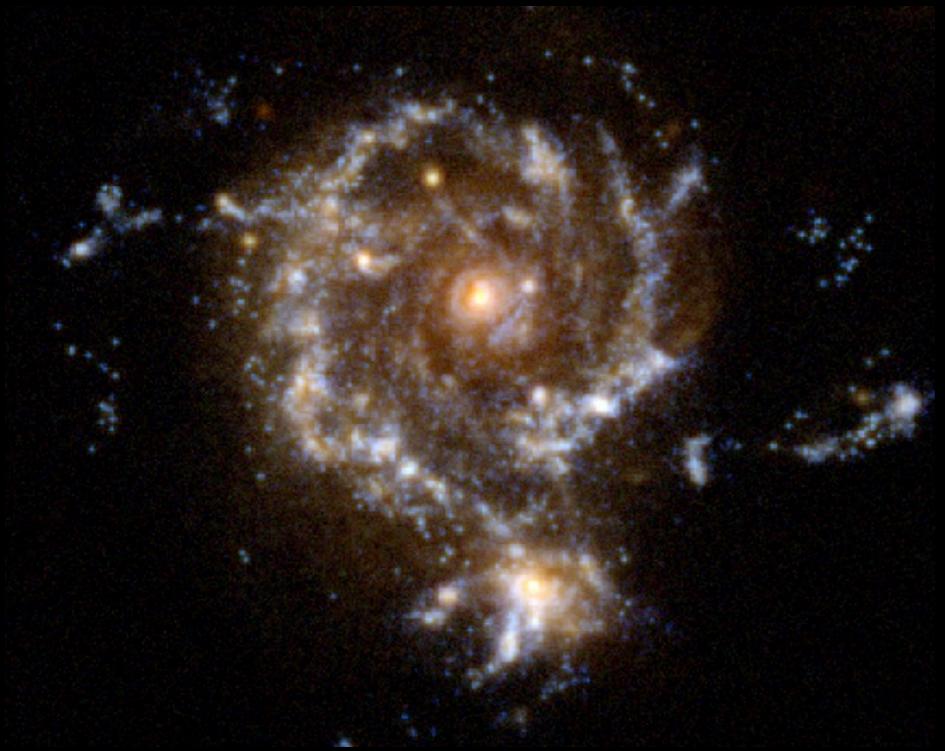


Credit: T. Robinson / G. Arney

Imagine astronomy with LUVOIR …

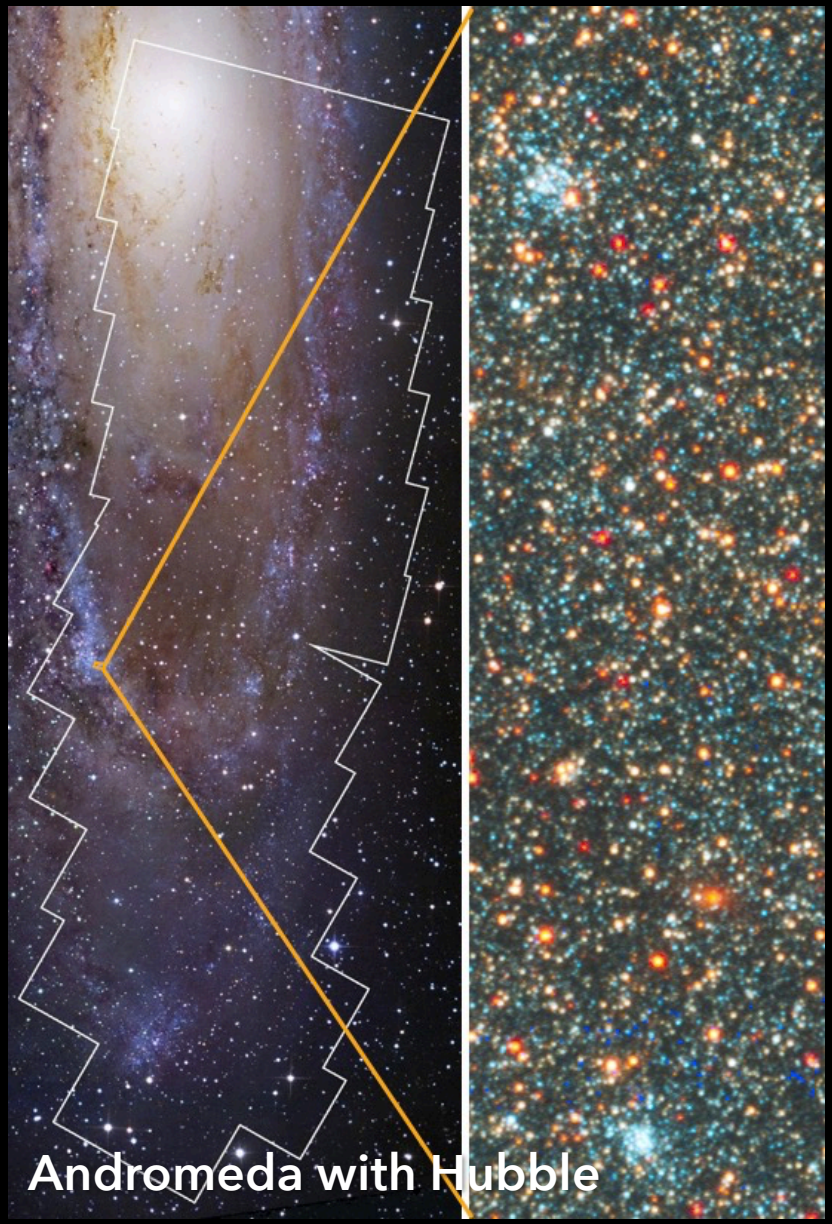


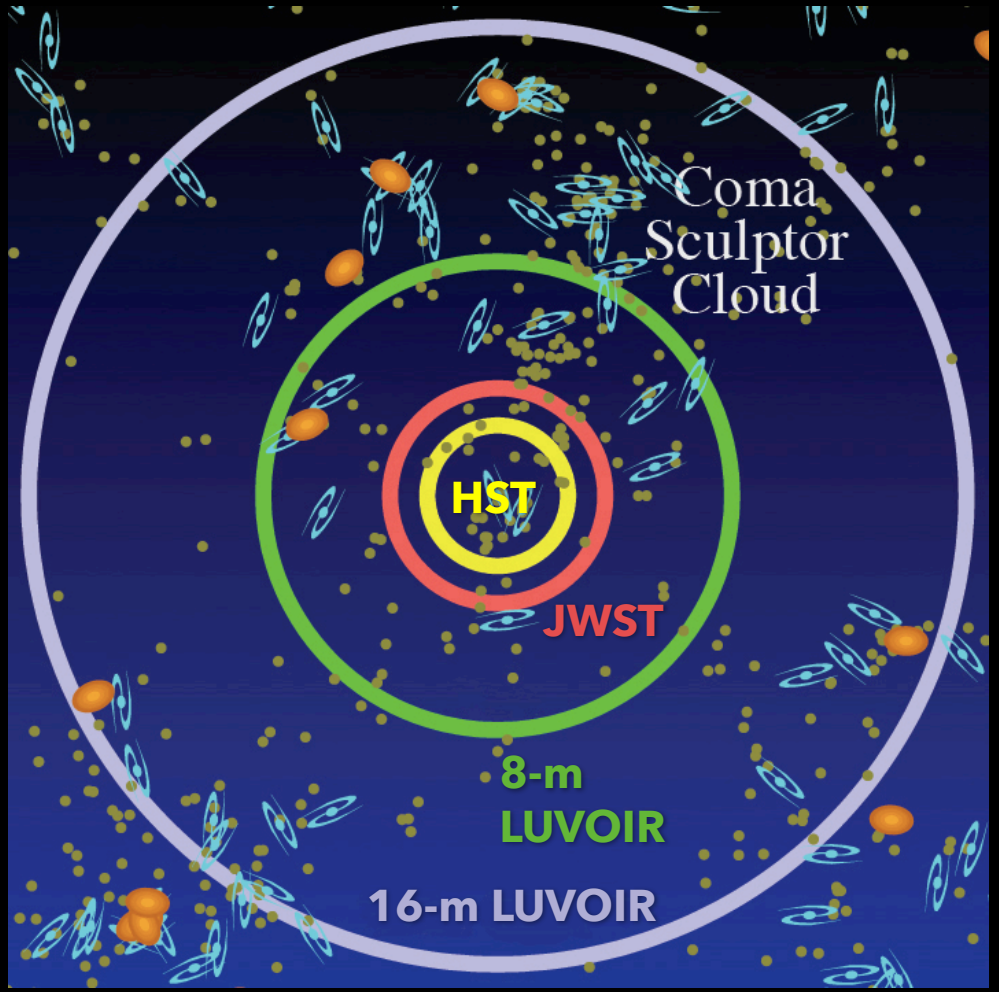
Galaxy at z = 2
with HST



Galaxy at z = 2
with 12-m LUVOIR

How do galaxies assemble their stars?





Map of Galaxies within 12 Mpc of Our Galaxy

= Large Elliptical Galaxy

= Dwarf Galaxy

= Large Spiral Galaxy

The least luminous galaxies as building block of galaxy formation

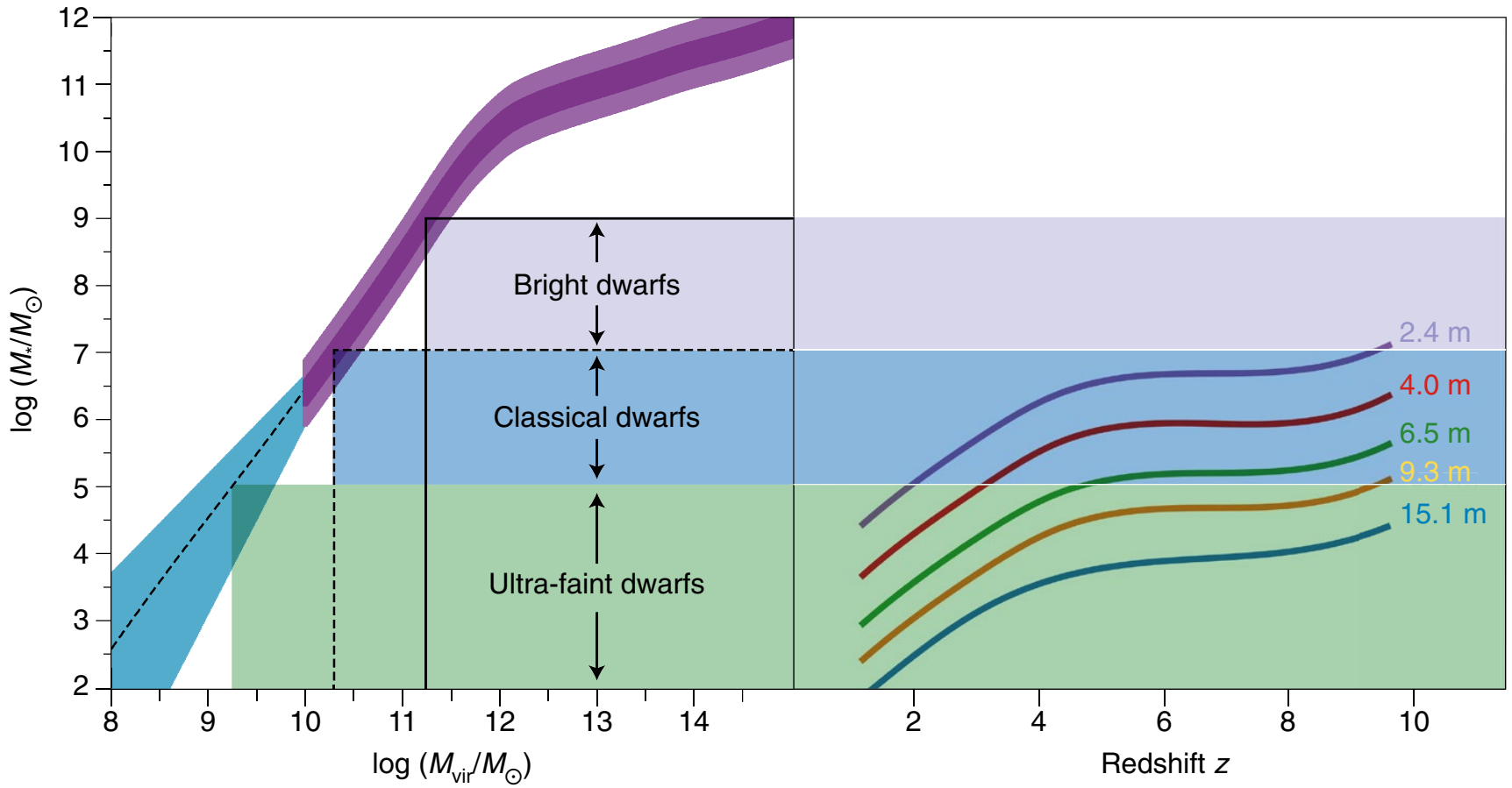
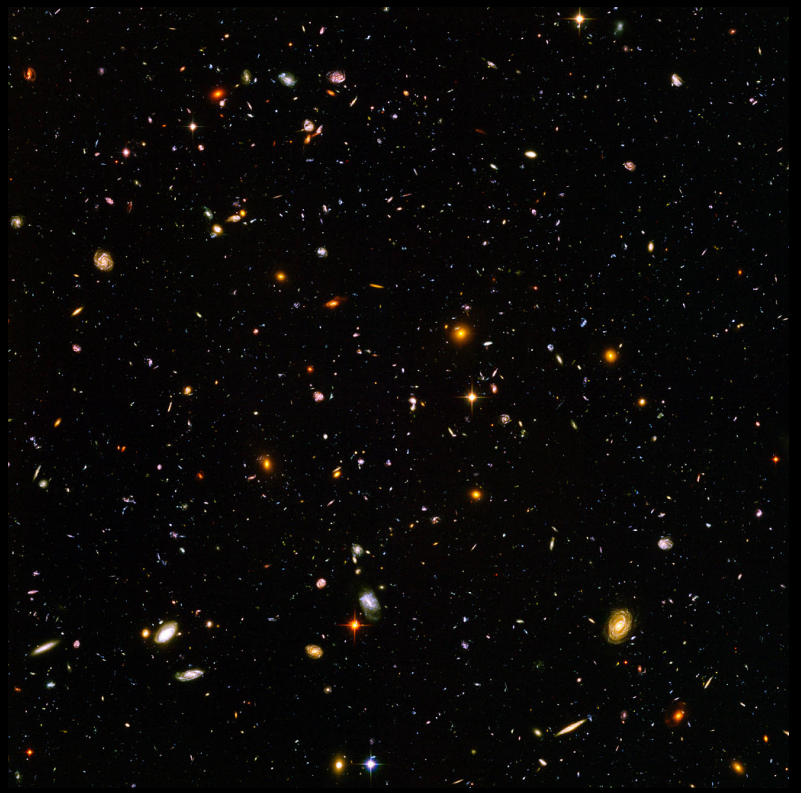


Fig. 2 | LUVOIR's view of the least luminous galaxies, the building blocks of galaxy formation, extends to eras when the Universe was just 3% of its current age. This corresponds to the $z = 10$ point in the right panel, which shows the galaxy mass detection limits for LUVOIR-type architectures, including the 15.1-m LUVOIR-A. M_* is the galaxy mass in stars and M_{vir} is the galaxy halo (virial) mass. Credit: left panel adapted from ref. [8], Annual Reviews; right panel M. Postman (STScI).

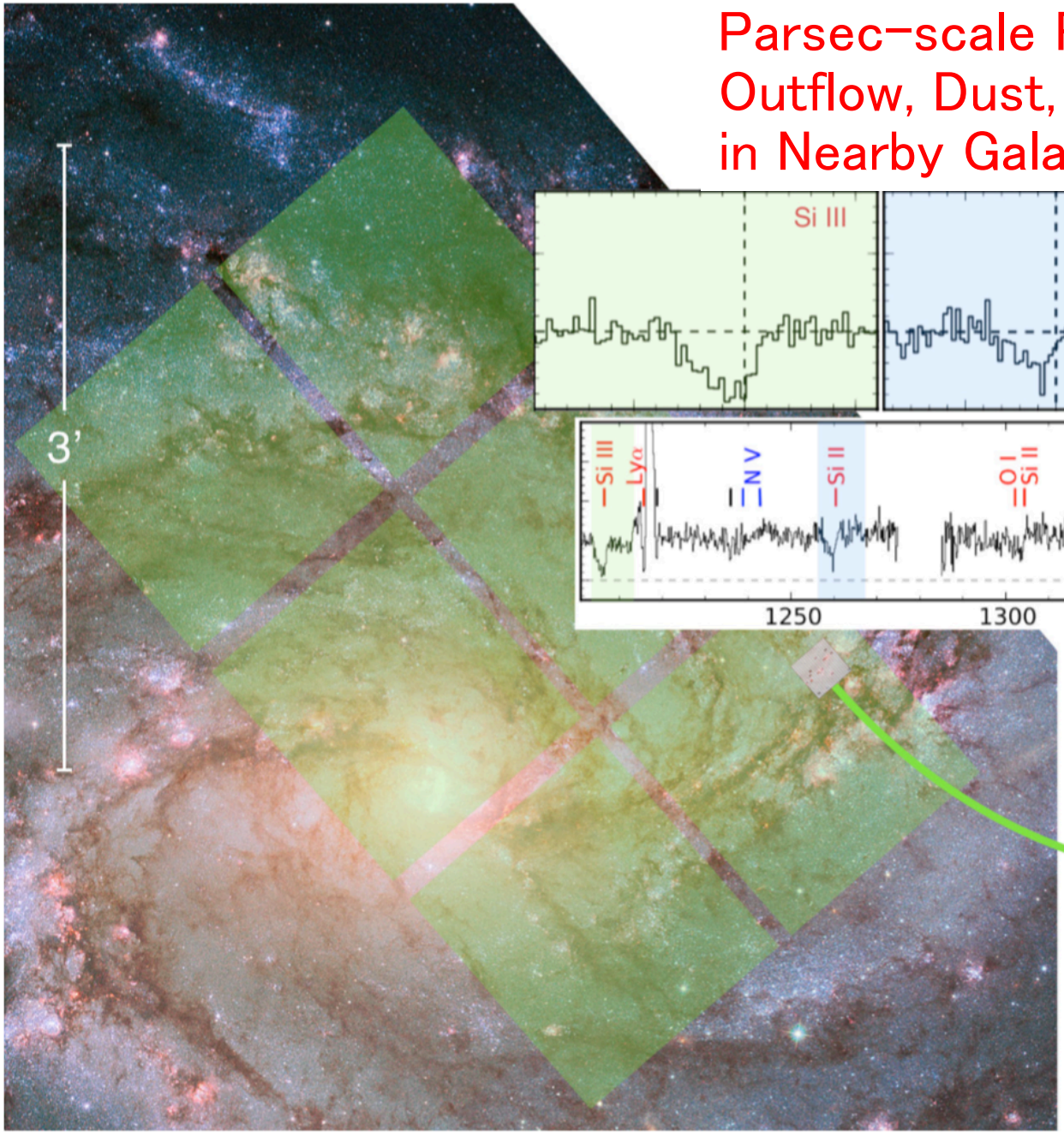
redefining deep fields

HUDF
400 orbits
11.3 days (~1 Million sec)
4 filters
m_{AB} ~ 29



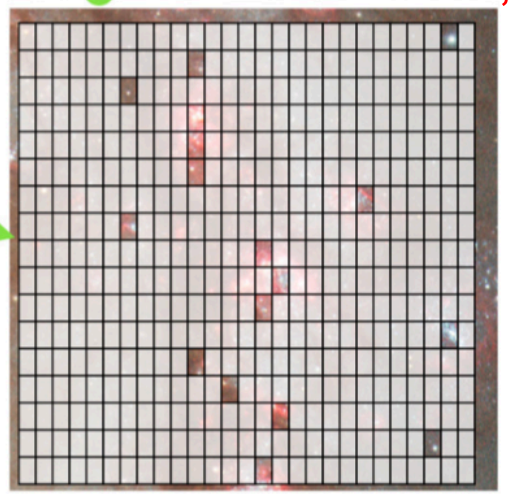
	Photometric bands, Limits are 5σ for point or point like sources in 100,000 seconds limits for 200,000 seconds are 0.4 mag deeper									
	F225W	F275W	F336W	F475W	F606W	F775W	F850W	F125W	F160W	F220W
15m	32.9	33.0	33.4	33.6	33.4	33.1	32.6	33.5	33.2	30.2
9m	31.8	32.0	32.4	32.5	32.4	32.2	31.6	32.4	32.2	29.2

Micro shutter in LUMOS



Parsec-scale Resolution of Inflow, Outflow, Dust, and Radiative transfer in Nearby Galaxies

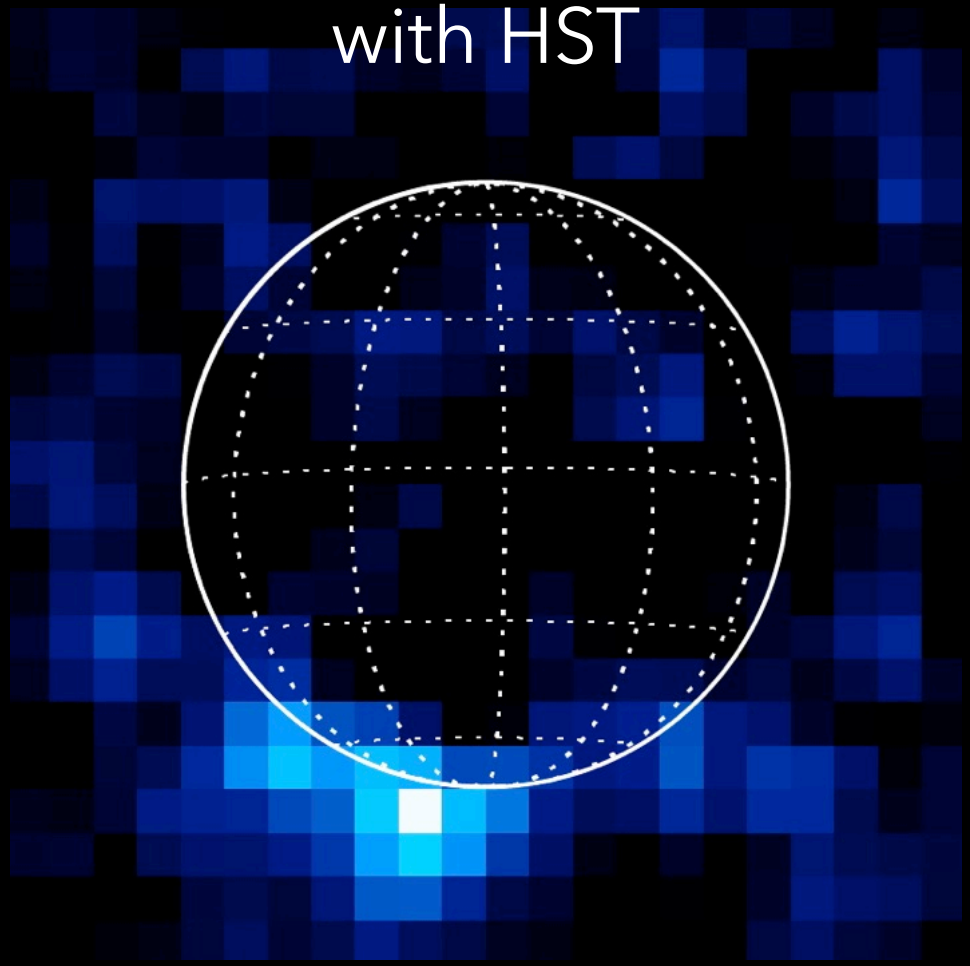
500 ≤ R ≤ 120,000



4x420x840

Imagine astronomy with LUVOIR …

Europa jets observed with HST



Roth et al. (2014)

Europa jets observed with 15-m LUVOIR

Credit: G. Ballester (LPL)

UV hydrogen emission

Imagine astronomy with LUVOIR …

Pluto with HST

Pluto with 15-m LUVOIR

Credit: W. Harris (LPL)

Possible contributions from Japan

- Components in Coronagraph instrument **ECLIPS**: coronagraph mask, polarization components. where we can leverage the heritage of Subaru/HiCIAO, WFIRST CGI and so on.
- UV detectors in **LUMOS, POLUX**: Funnel MCP, CMOS electronics, photon-counting device, UV Diffraction grating. Where we can leverage the heritage of HISAKI satellite and development of UV detectors for the ESA's ARIEL mission.
- Ultra-stable Transit spectrograph: as an alternative instrument or 2nd generation instrument.
- Ground station to downlink in Ka-band and TT&C (Telemetry, Tracking, and Command)
- Development of data processing pipelines and Sciences.

Summary

LUVOIR has multiple primary science goals

① Habitable exoplanets & biosignatures

② Broad range of general astrophysics and Solar System observations

LUVOIR will provide a statistical study of Goal 1,

factors of ~ 100 increased science grasp over Hubble for Goal 2