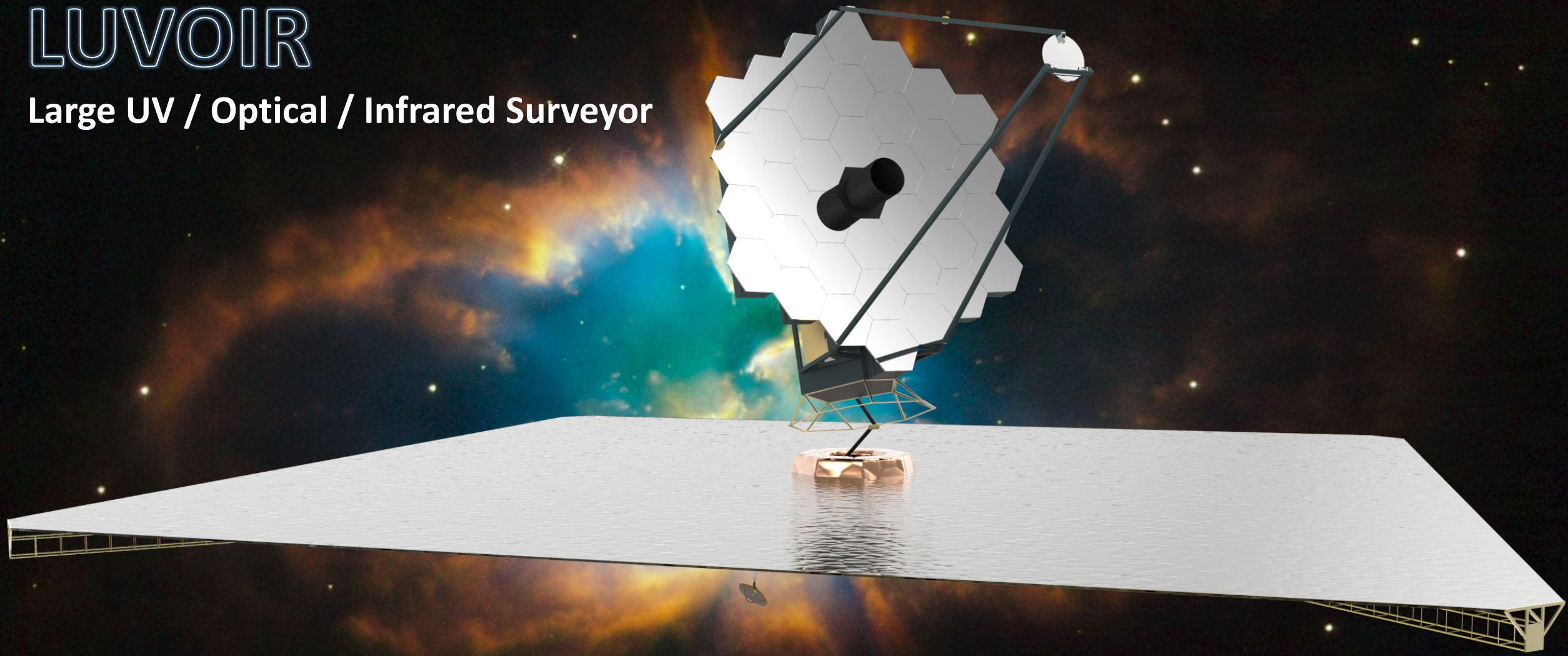
LUVOIR

Large UV / Optical / Infrared Surveyor



Un concept de télescope spatial dans la tradition du HST

A little bit of context

January 2015 → NASA Astrophysics Division initiated a community-based process for identifying large mission candidates by the 2020 Decadal Survey, to follow JWST and WFIRST

- Science Case
- Design reference mission with strawman payload
- Technology developments needs
- Cost requirements assessment (large mission → total cost exceeding $1B)

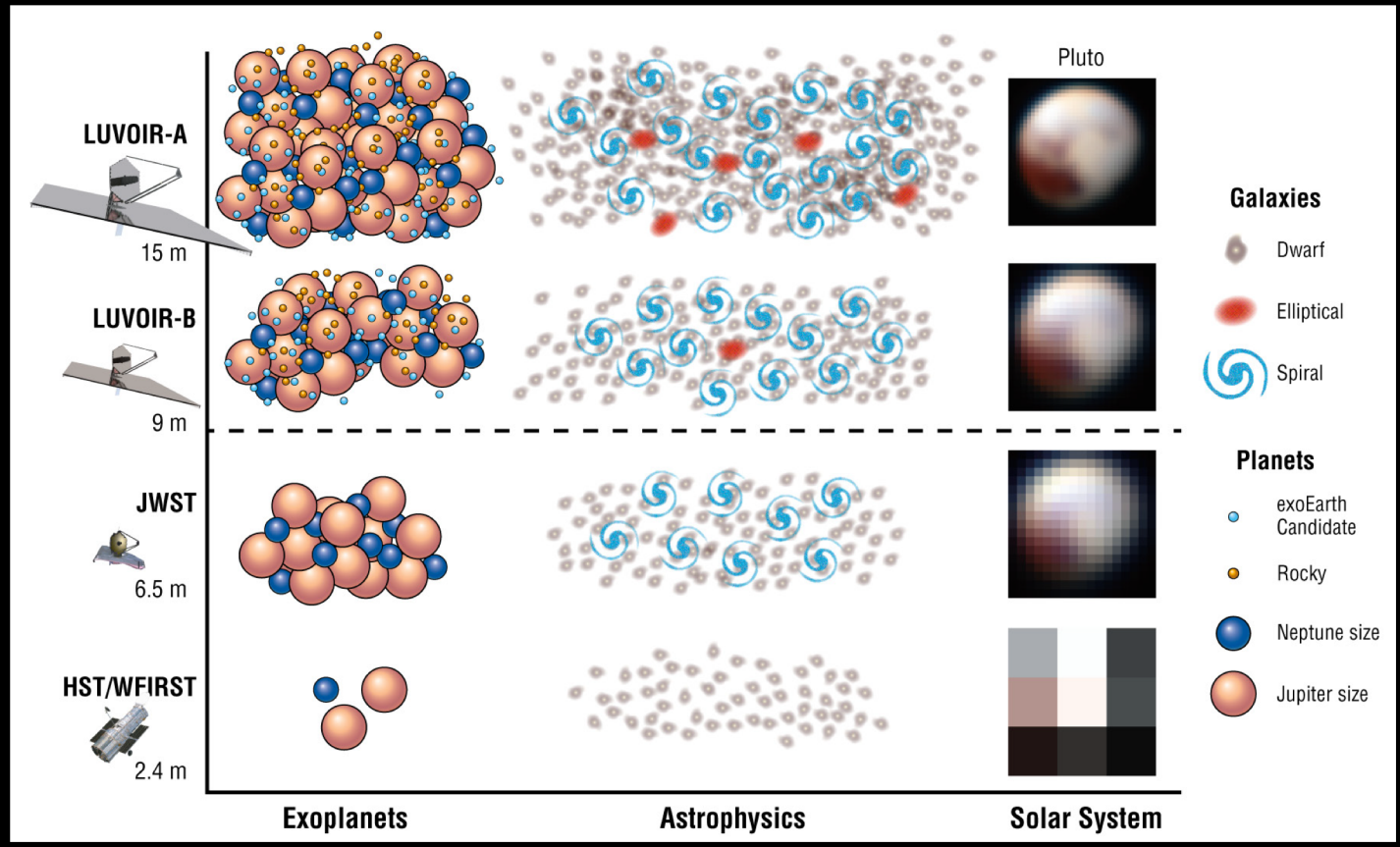
- The Far Infrared Surveyor (Origins Space Telescope - https://asd.gsfc.nasa.gov/firs/)
- The Habitable-Exoplanet Imaging Mission (HabEx - https://www.jpl.nasa.gov/habex/)
- The X-ray Surveyor (Lynx - https://wwwastro.msfc.nasa.gov/lynx/)
- The Large UV, Optical, and Infrared Surveyor (LUVOIR - https://asd.gsfc.nasa.gov/luvoir/)

- LUVOIR: Telling the Story of Life in the Universe
- *Is there life elsewhere?*
- *Is our world unique?*
- *How do stars form?*
- *What are the building blocks of structure?*
- *How did our galaxy, solar system, and Earth arise and evolve?*

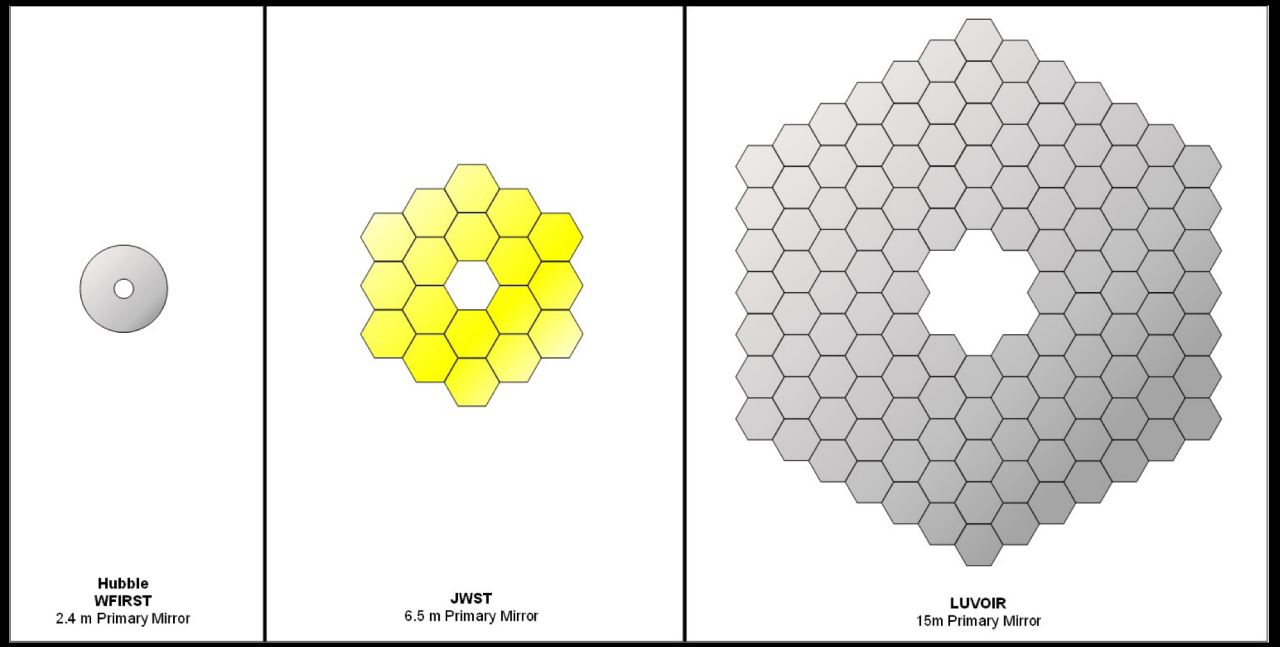
General Science Drivers

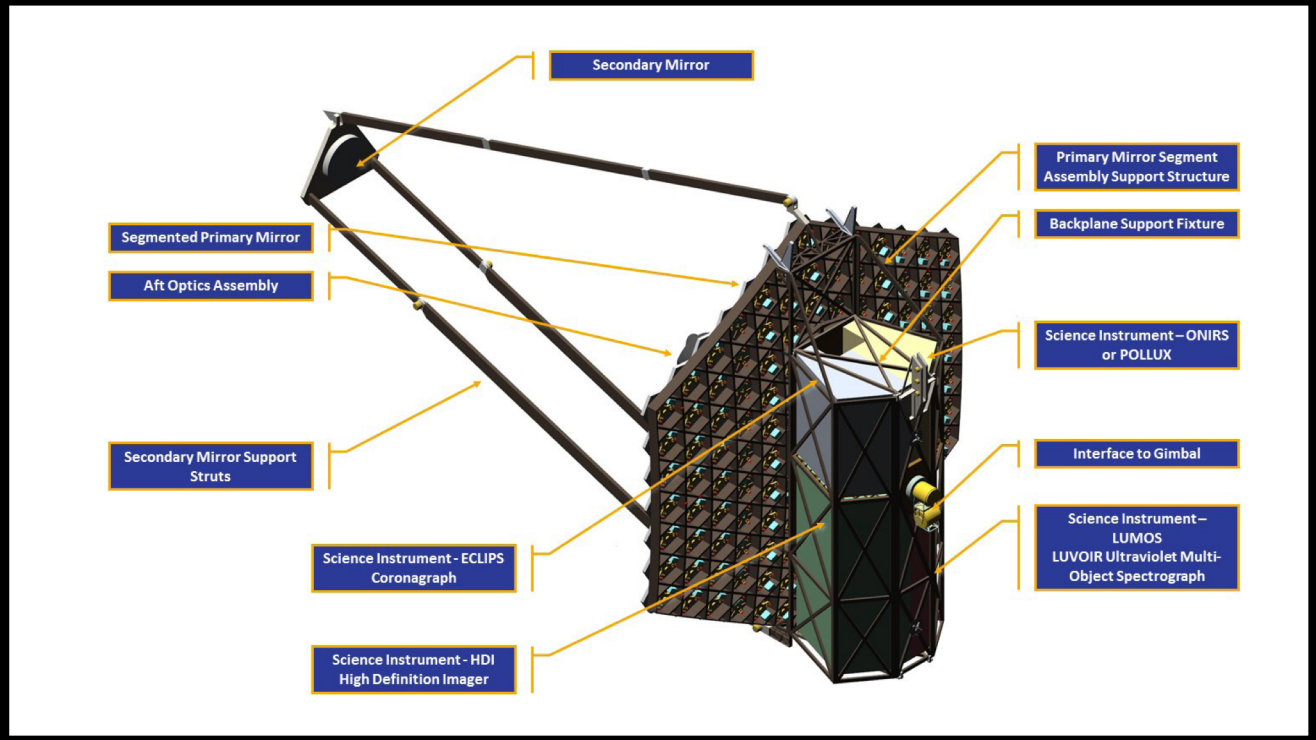
Epoch	Aperture	Wavelength	
		UV (100–300 nm)	Near-IR (to 2 μm)
$z = 1–4$	Resolve ALL galaxies to 100 parsec or better, to individual massive star-forming regions (Section 4.1.1)	Detect massive star formation in the smallest pre-galactic building blocks (Section 4.1.1)	Observe building blocks of galaxies in rest-fame optical (Section 4.1.1)
$z = 0.5–1$	Identify stellar progenitors and hosts for diverse transients (Section 4.2.2)	Detect emission and absorption from gas accreting and recycling into galaxies (Section 4.2.1)	Map galactic star-formation and gas dynamics with rest-frame optical diagnostics (Section 4.2.1)
	Reach 100s of background QSOs for outflow and IGM/CGM studies (Section 4.2.1)	Detect hot plasma ejected by SMBHs acting as feedback on their galaxies (Section 4.2.1)	
<100 Mpc	Resolve stars down to 1 $M_\odot$ out to the nearest giant ellipticals and clusters out to 30 Mpc (Sections 4.3.1 and 4.3.3)	UV mass functions of young stellar clusters (Section 4.3.1)	Low-extinction and reddening-free stellar population diagnostics
	Watch motion of virtually any MW star, LG satellites, and ellipticals in Virgo cluster (Section 4.3.4)	Use UV MOS/IFU to dissect multiphase gas feedback flows in nearby galaxies (Section 4.3.2)	
<100 kpc	Resolve individual stars in young clusters everywhere in the MW and Magellanic Clouds (Section 4.4.1)	Measure protostellar accretion from UV to Magellanic Clouds (Section 4.4.1)	Peer into protostellar disks to look for planets (Section 4.4.2)
	Examine protoplanetary disks at ~1–3 AU resolution to >100 parsec (Section 4.4.2)	Obtain disk abundances of C, N, O, Si, Fe from UV lines (Section 4.4.2)	
<50 AU	Resolve surface and cloud features down to 50 km at outer planets and 200 km at Kuiper belt (Section 4.5)	Planetary magnetospheres and the Sun-Planet connection (Section 4.5.1)	Mapping the spatial structure of surface ices on moons (Section 4.5.2)
	Census of outer Solar System (TNOs, KBOs) to small mass and large distance (Section 4.5.3)	Detect emission from planetary coronae and aurorae, volcanism, and geysers (Section 4.5.2)	Detection of smallest and furthest objects (Section 4.5.2)

- LUVOIR: Telling the Story of Life in the Universe
- 9 - 15 m mirror aperture
- Diffraction limited at 500 nm
- Segmented, deployable, utra-stable telescope
- Broad wavelength coverage from 100 nm – 2.2 μm
- Halo orbit about the Sun-Earth L2 point
- Serviceable and Upgradable
- Lifetime ~ 25 years for non-serviceable components
- Suite of Coronograph, Imager and Spectrographs
- Guest observer-driven program
- Launch date ~ 2035



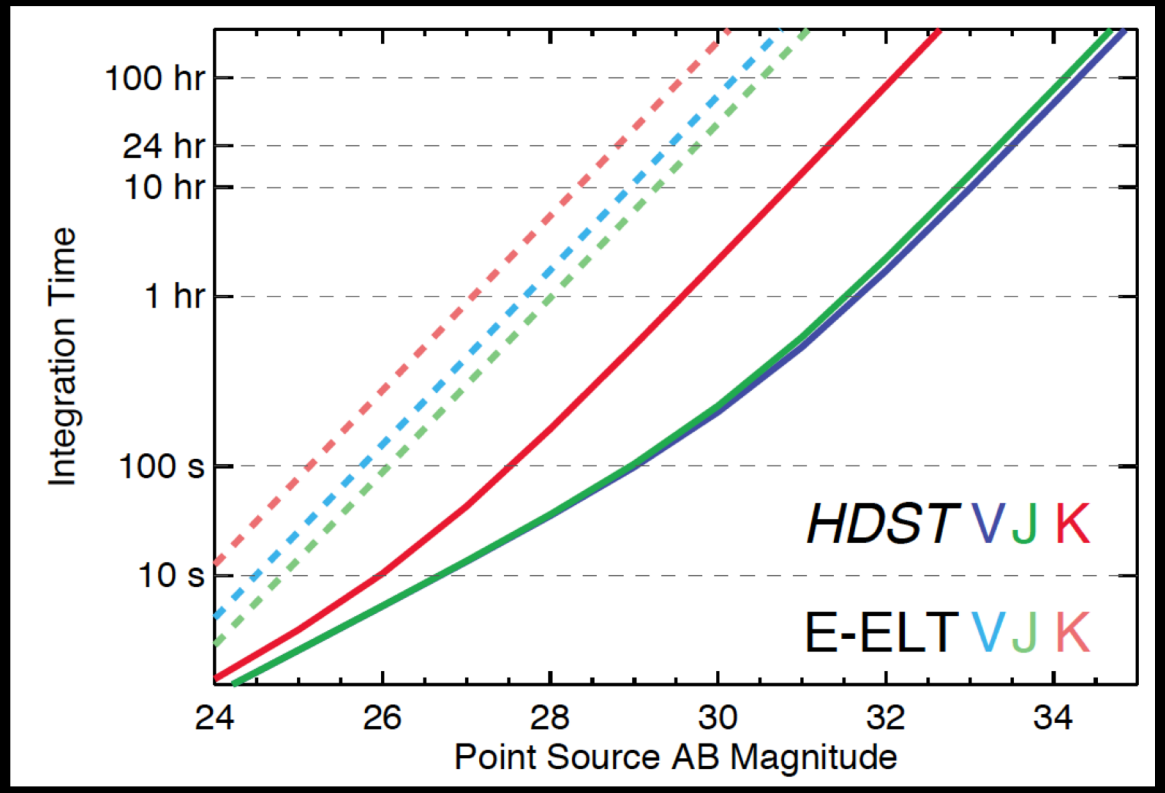
- Instantaneous Field-of-View: 10’ x 8’
- 1.15-m flat-to-flat segments (120x)
- Effective area is 135 m^2





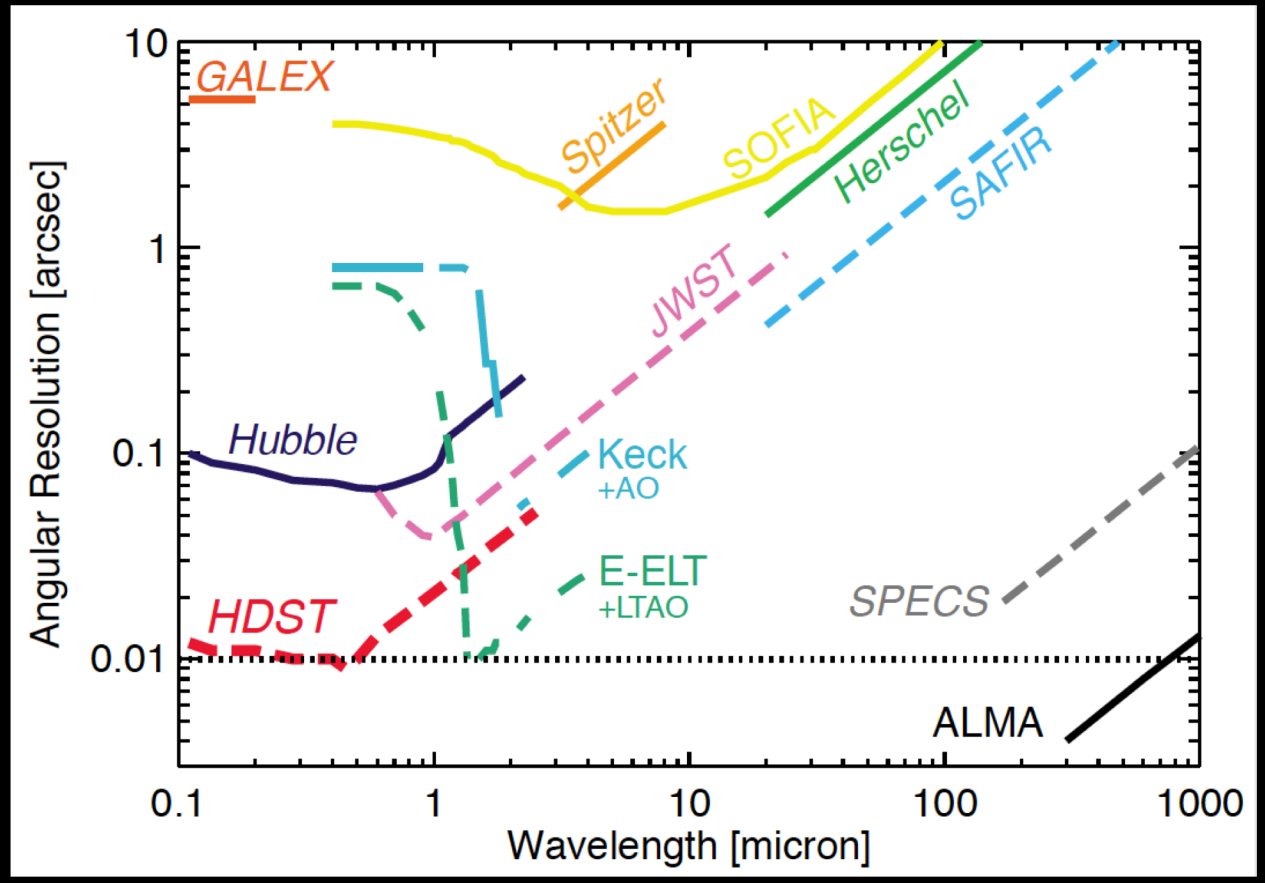
15-m diameter aperture, 4 instrument bays:

- Optical / NIR Coronagraph
- High-definition Imager
- UV Multi-object Spectrograph (“LUMOS”)
- Pollux: UV High-Resolution Spectro-polarimeter

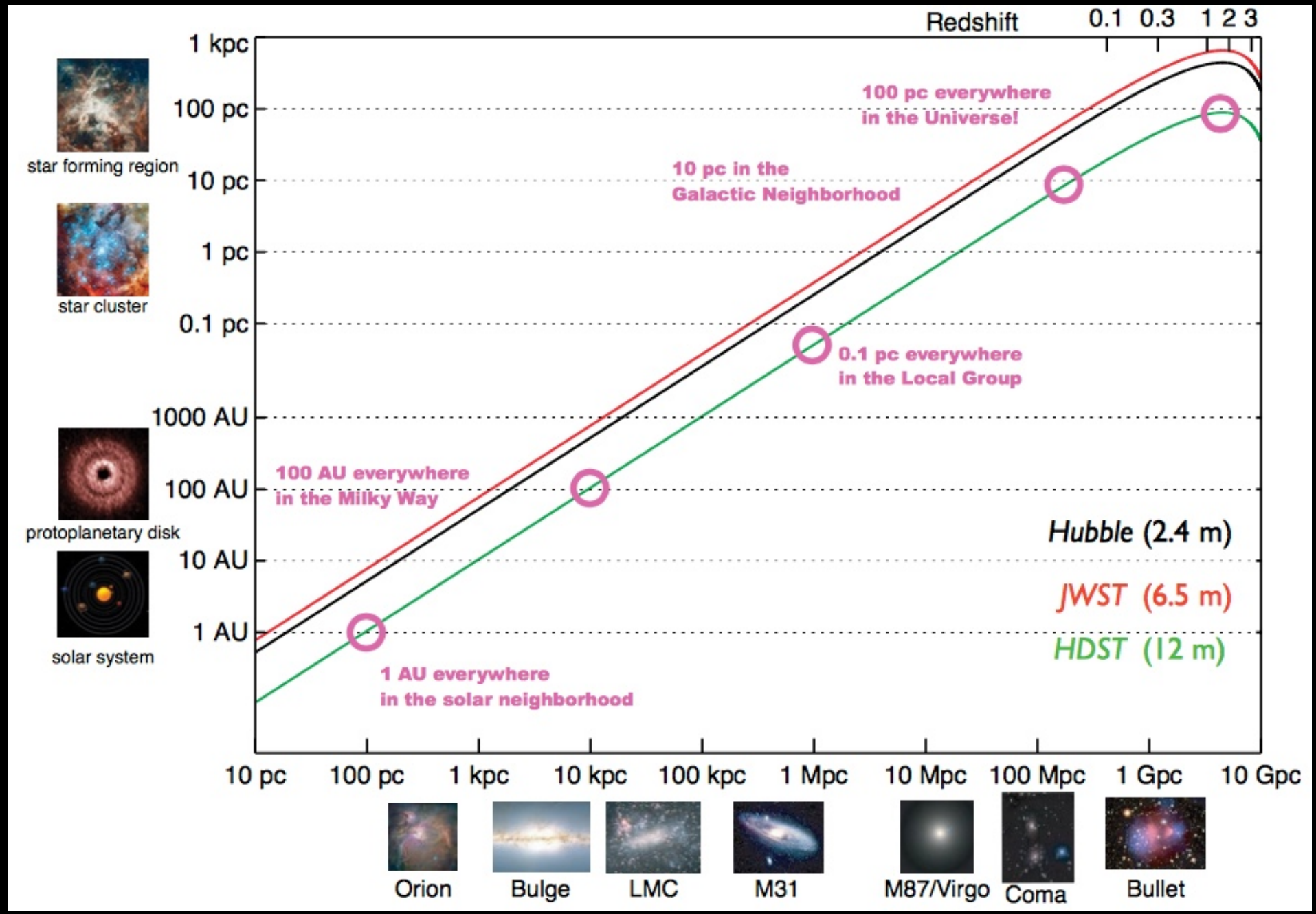


Total integration time to reach a 10-sigma point-source limiting magnitude

The E-ELT is assumed to perform at its diffraction limit at wavelengths longer than 1 micron and seeing-limited (0.6 arcsec) for wavelengths below 1 micron.



The resolution is shown assuming a 12 m aperture, diffraction limited at 500 nm


Redshift
0.1 0.3 1 2 3
1 kpc
100 pc
10 pc
1 pc
0.1 pc
1000 AU
100 AU
10 AU
1 AU
star forming region
star cluster
protoplanetary disk
solar system
100 pc everywhere
in the Universe!
10 pc in the
Galactic Neighborhood
0.1 pc everywhere
in the Local Group
100 AU everywhere
in the Milky Way
1 AU everywhere
in the solar neighborhood
Hubble (2.4 m)
JWST (6.5 m)
HDST (12 m)
10 pc
100 pc
1 kpc
10 kpc
100 kpc
1 Mpc
10 Mpc
100 Mpc
1 Gpc
10 Gpc
Orion
Bulge
LMC
M31
M87/Virgo
Coma
Bullet

High Definition Imaging Instrument

UV/Vis Imaging (200 nm - ~1.0 µm) - Diffraction-limited at 500 nm

NIR Imaging (~1.0 µm – 2.5 µm) - Diffraction-limited at 1.2 µm

Each channel contains a suite of spectral filters (narrow, med and brodband)

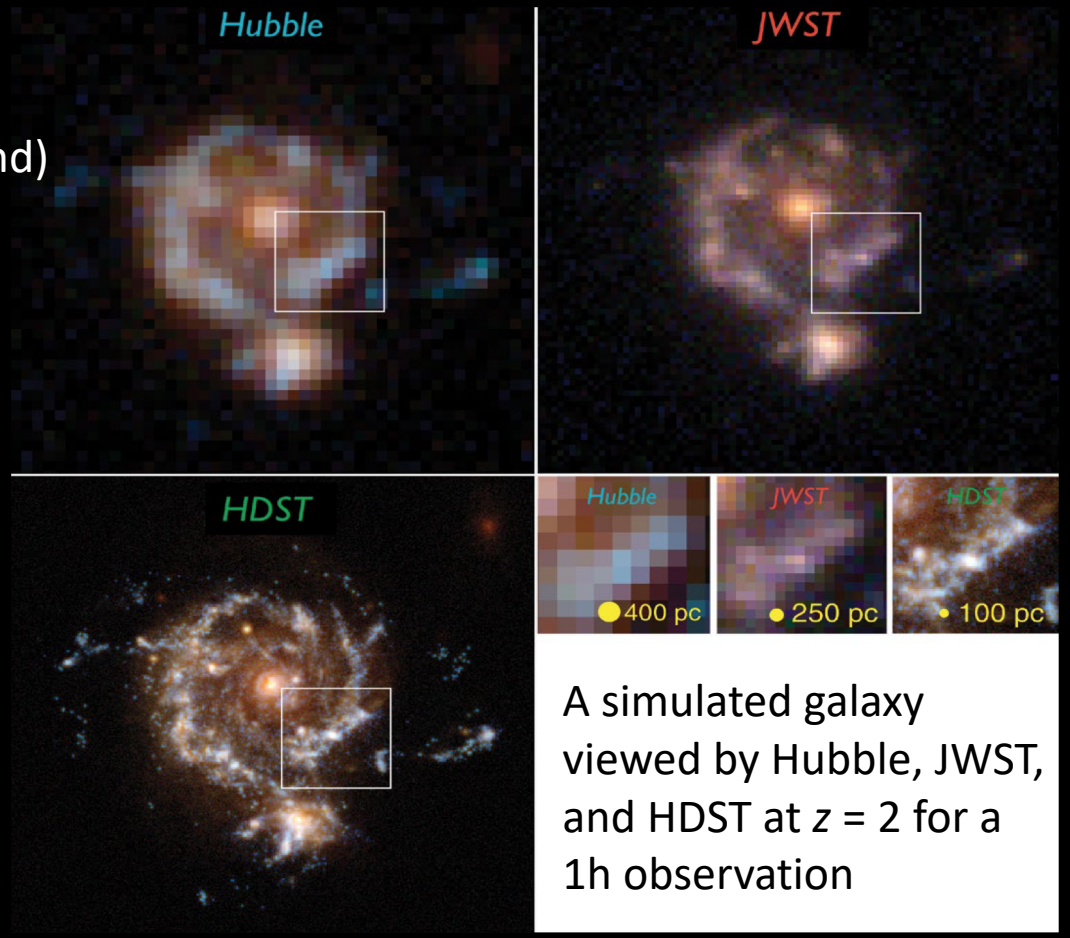
Field-of-view: 2 x 3 arcmin

High precision astrometry (~0.1 μas)

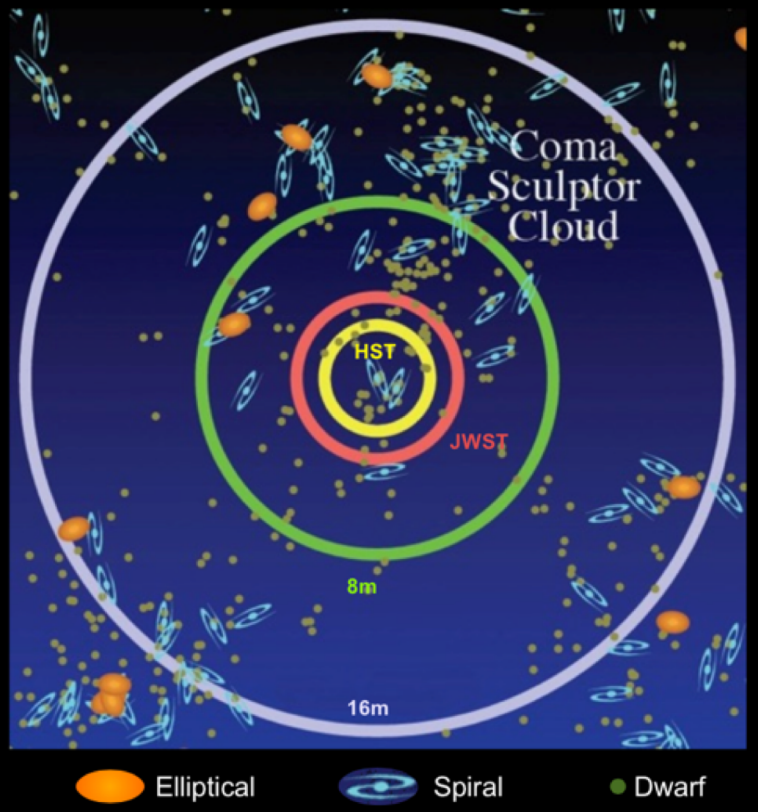
High-speed photometry with 50 ms exposures

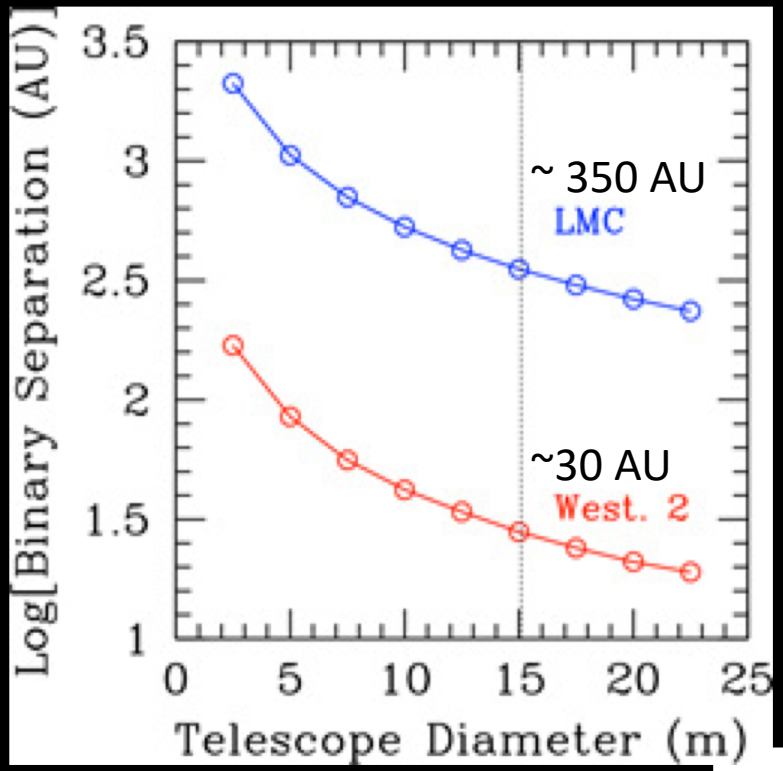
High Precision Astrometry (for exoplanets masses)

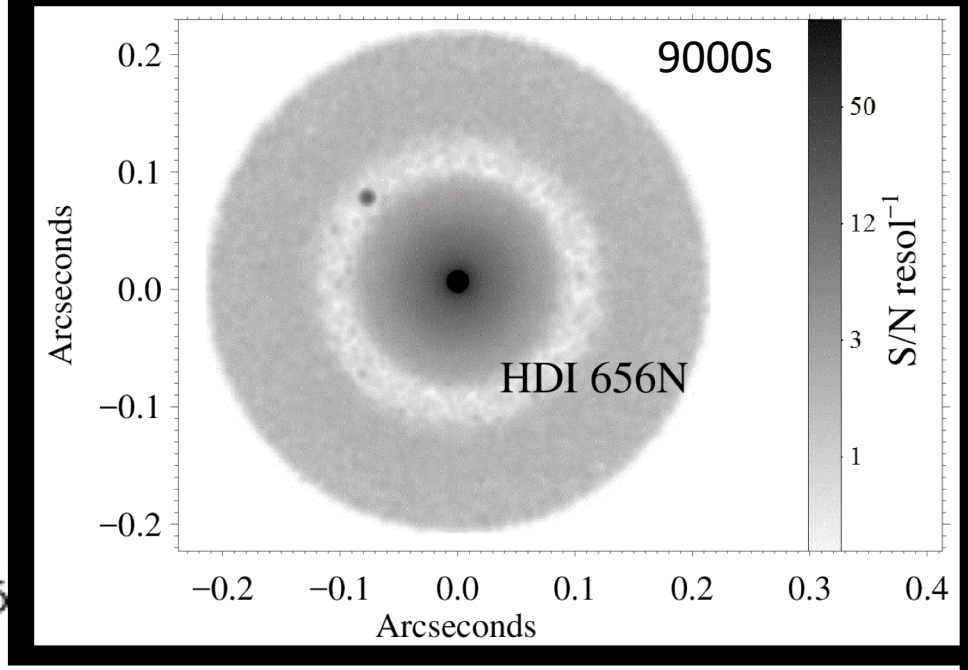
5σ photometric limits of AB = 33–33.5 for point sources



A simulated galaxy viewed by Hubble, JWST, and HDST at z = 2 for a 1h observation

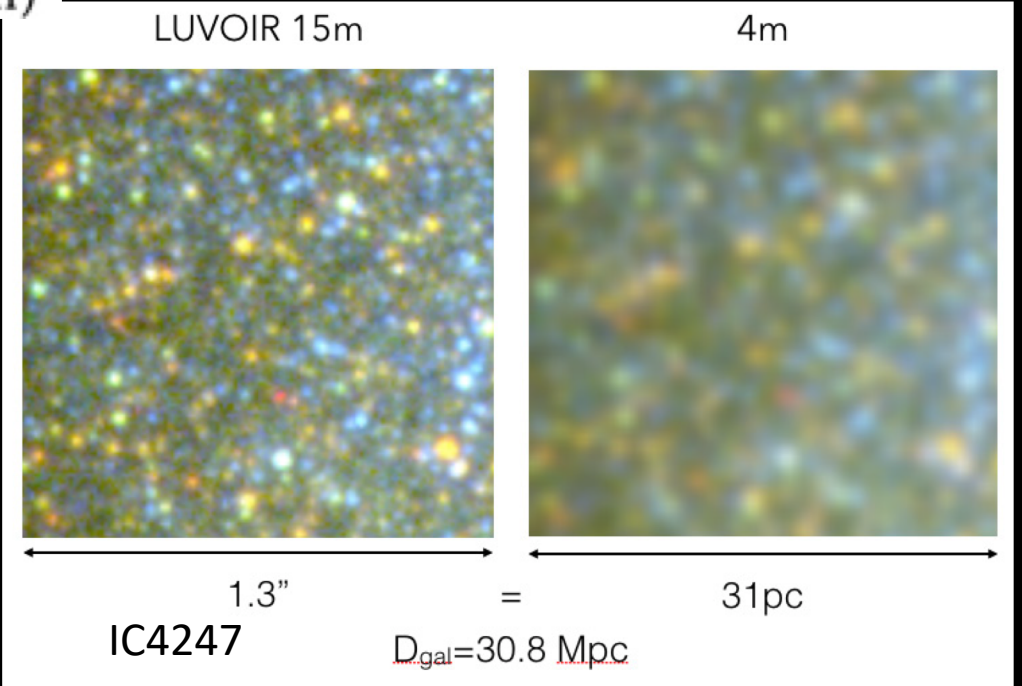






Spectral signatures of individual stars and star clusters and groups in galaxies (d<~50 Mpc).

Imaging of stellar systems to identify multiplicity



LUVOIR UV Multi-Object Spectrograph

Multi-object imaging spectrograph, medium and low-resolution spectral modes

Near-UV IFU and NUV+FUV imaging mode

Spectral Bandpass: 100 – 400 nm (*90 – 400 nm*)

Spectral Resolving power:

M = 15,000 – 60,000

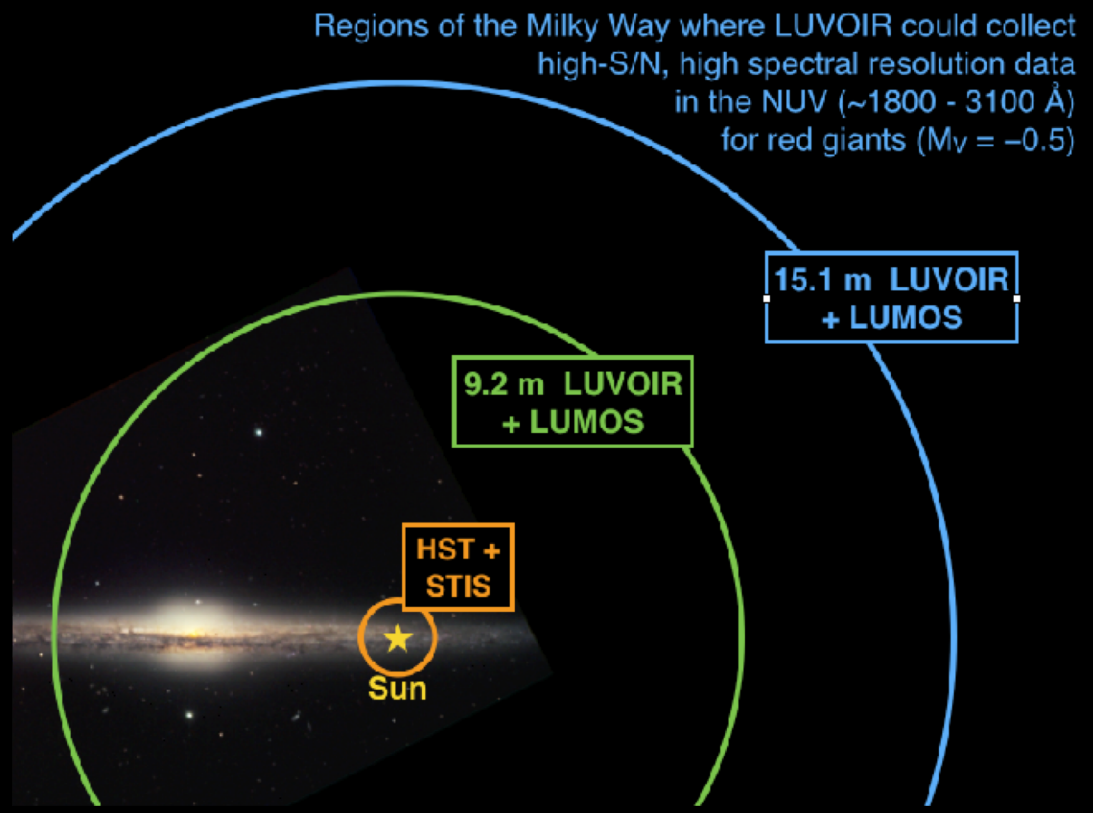
L = 5,000 – 15,000 and LL = 500

Temporal Resolution: 1msec

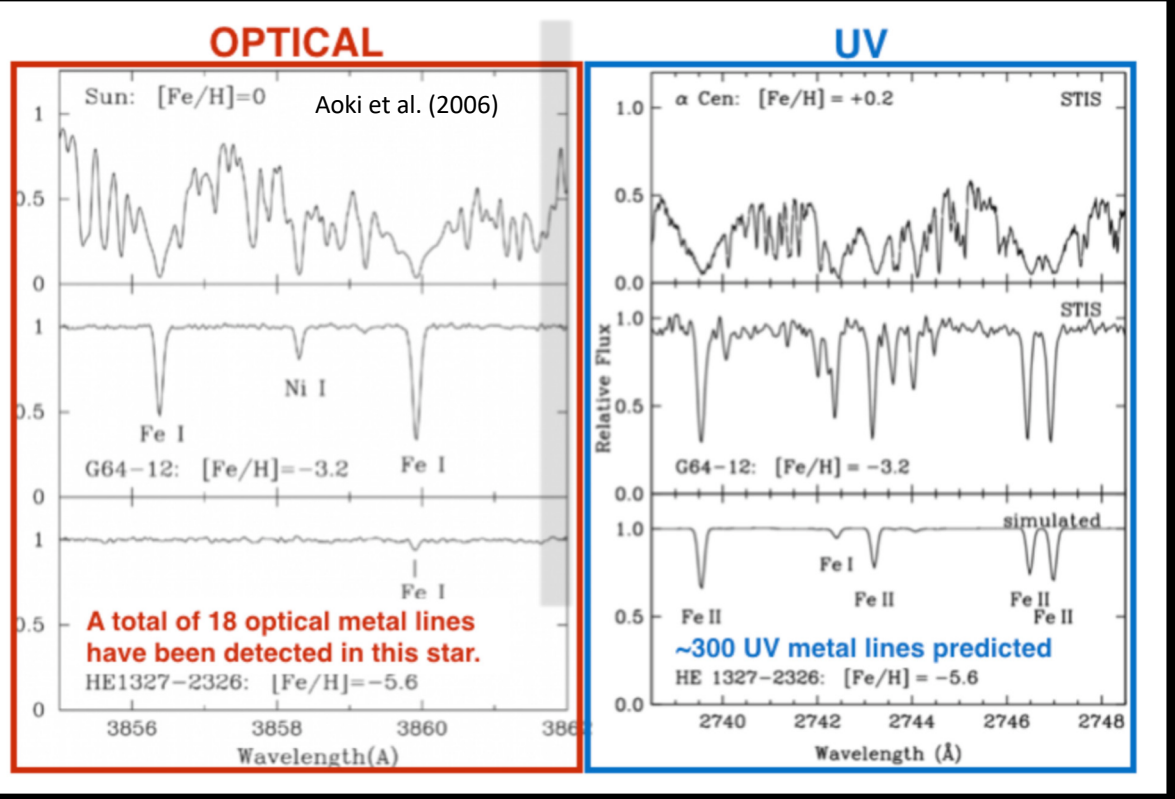
Multi-object FoV: 3’ x 2’

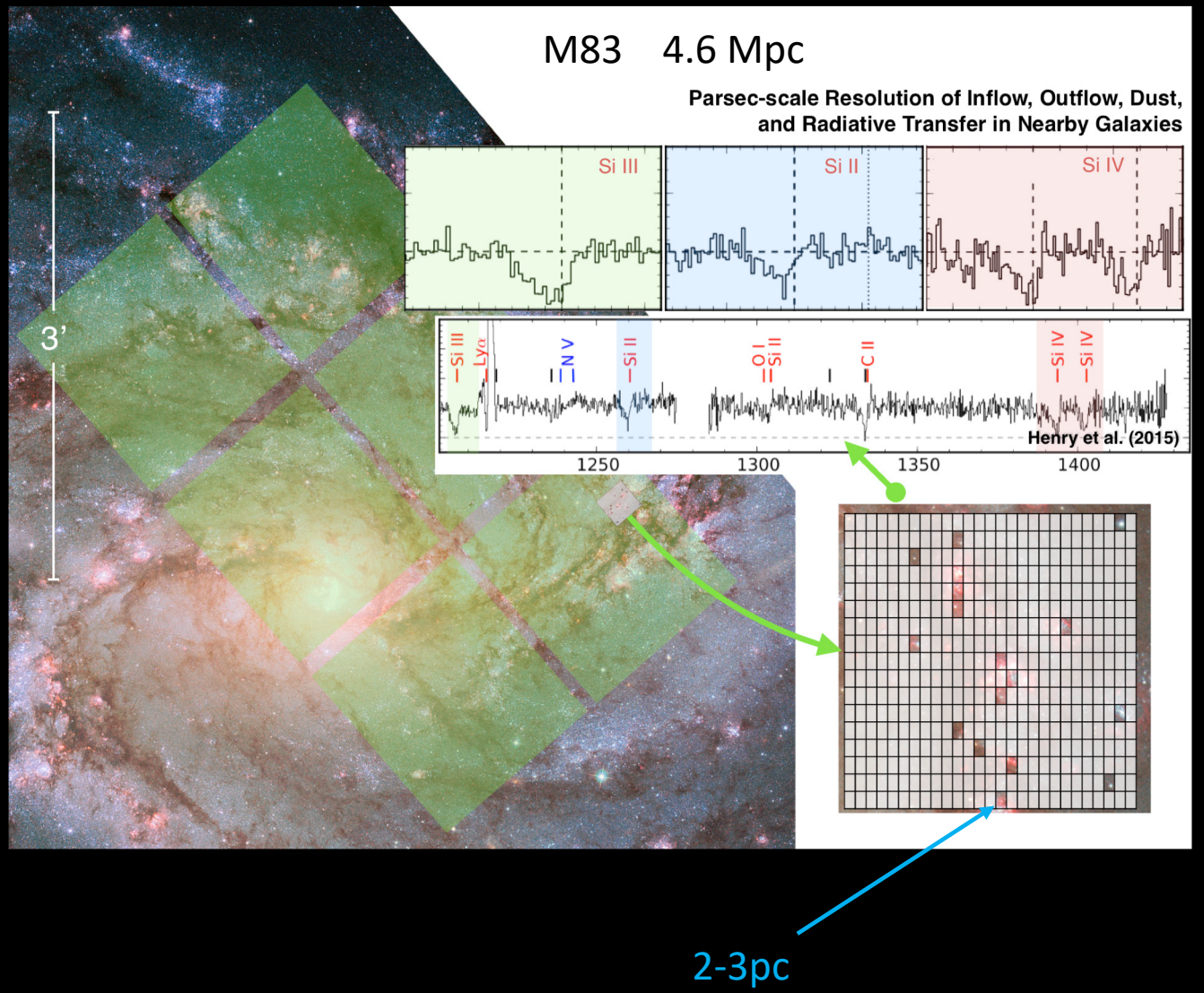
Micro-shutter array 0.14’’ x 0.07’’

Angular Resolution in MOS mode: 30 mas

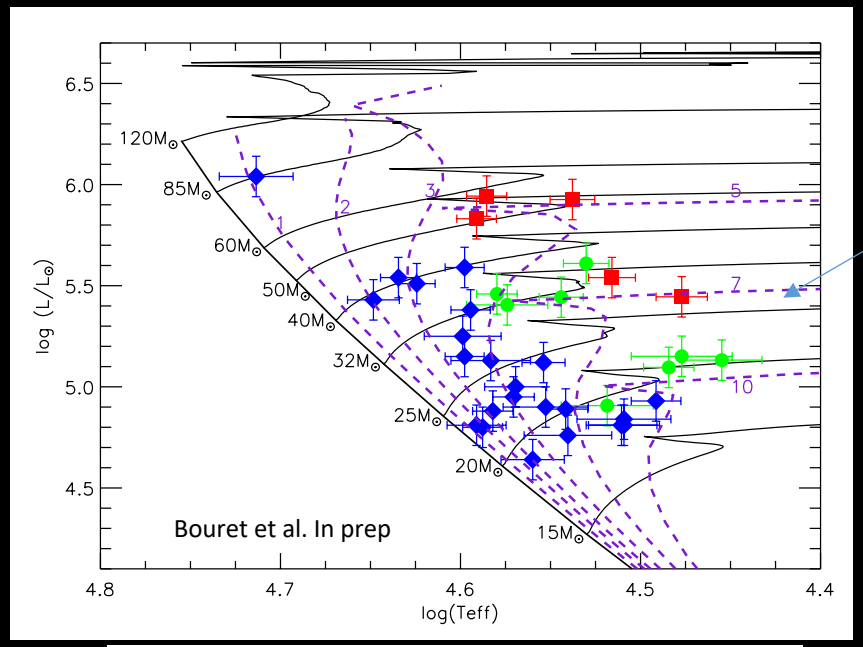


LUMOS: 25th mag galaxy at 5σ in 1 hour


OPTICAL
UV
Sun: [Fe/H]=0
Aoki et al. (2006)
Ni I
Fe I
G64-12: [Fe/H]=-3.2
A total of 18 optical metal lines
have been detected in this star.
HE1327-2326: [Fe/H]=-5.6
Wavelength(A)
α Cen: [Fe/H] = +0.2
STIS
Relative Flux
simulated
Fe II
~300 UV metal lines predicted
HE 1327-2326: [Fe/H] = -5.6
Wavelength (Å)


M83 4.6 Mpc
Parsec-scale Resolution of Inflow, Outflow, Dust,
and Radiative Transfer in Nearby Galaxies
Si III
Si II
Si IV
3'
Henry et al. (2015)
2-3pc

Massive stars in the Magellanic Clouds

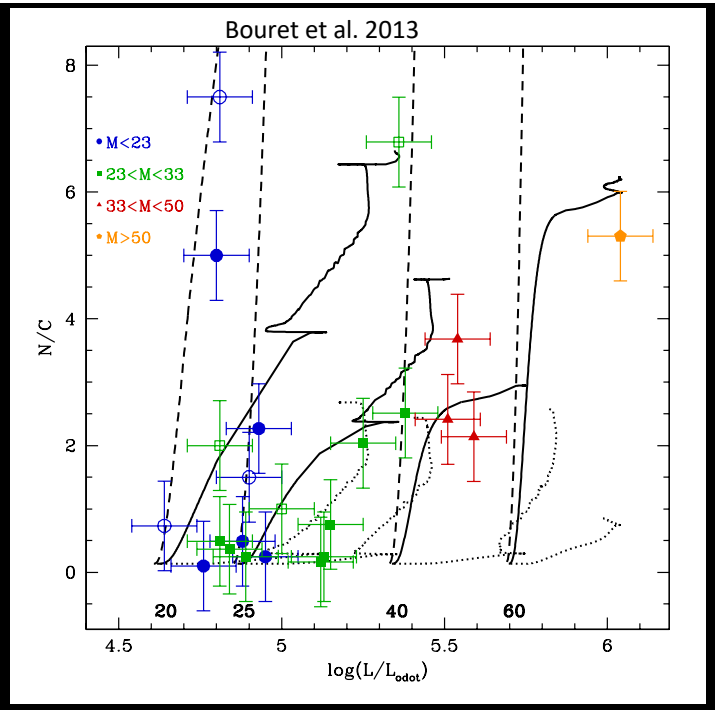


SMC➔ 60kpc

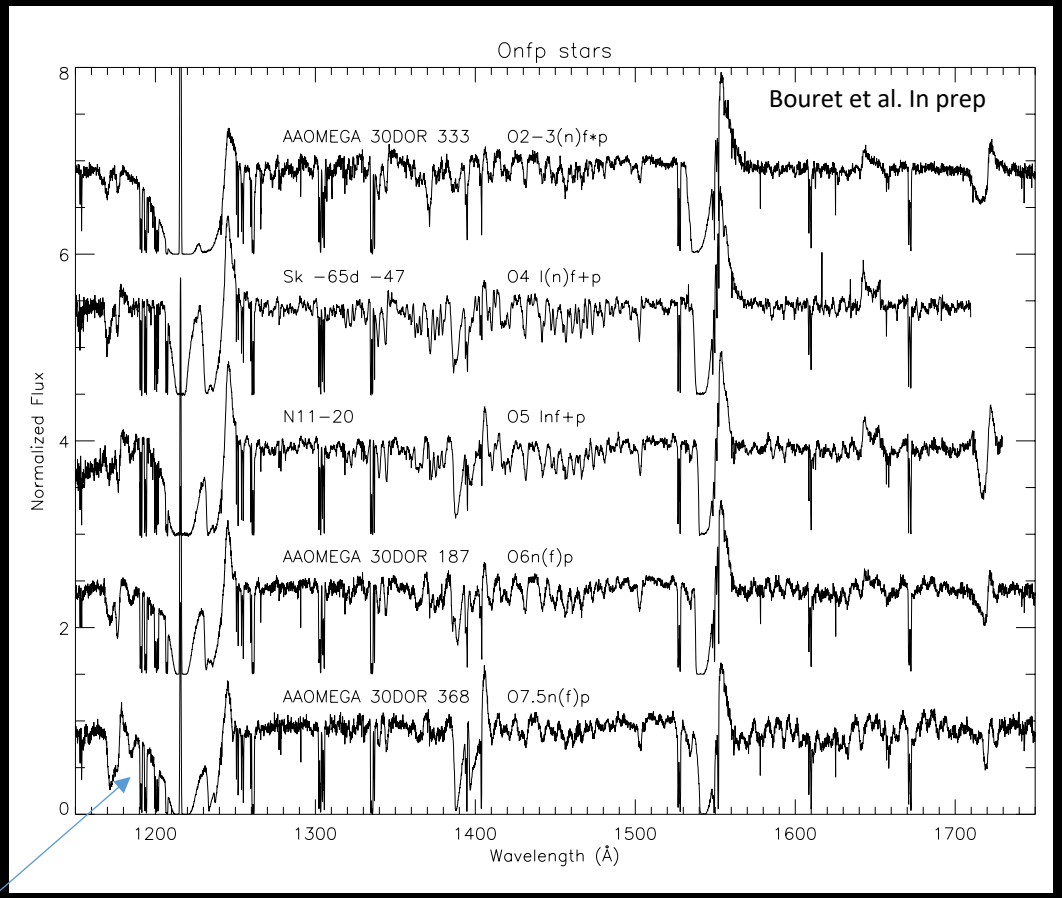
The largest sample of massive stars in the SMC

$Z \sim 0.2 Z_{\odot}$ ➔ lower mass-loss than in the Galactic case

Surface abundances



LMC ➔ 50kpc
$Z \sim 0.5 Z_{\odot}$

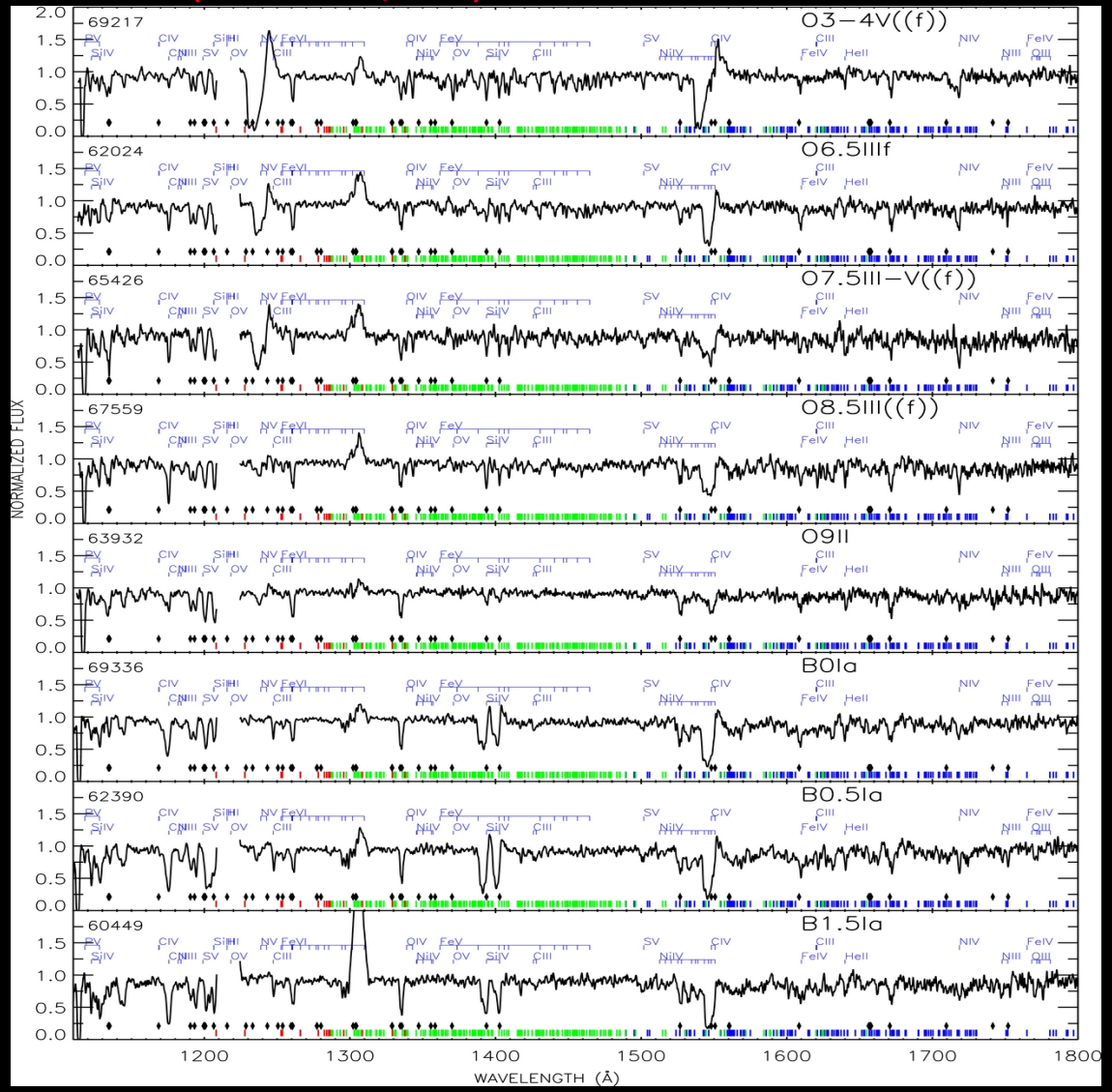


Rapid rotation and mass loss are expected to play a crucial role in creating the conditions required by LGRB models ➔ 2D RT models to probe the properties of the wind structure/velocity law

Massive stars beyond the Local Group

HST/COS → IC1613 (0.7Mpc) and WLM (0.9Mpc)

low R (2-5 orbits/star) → 8 stars

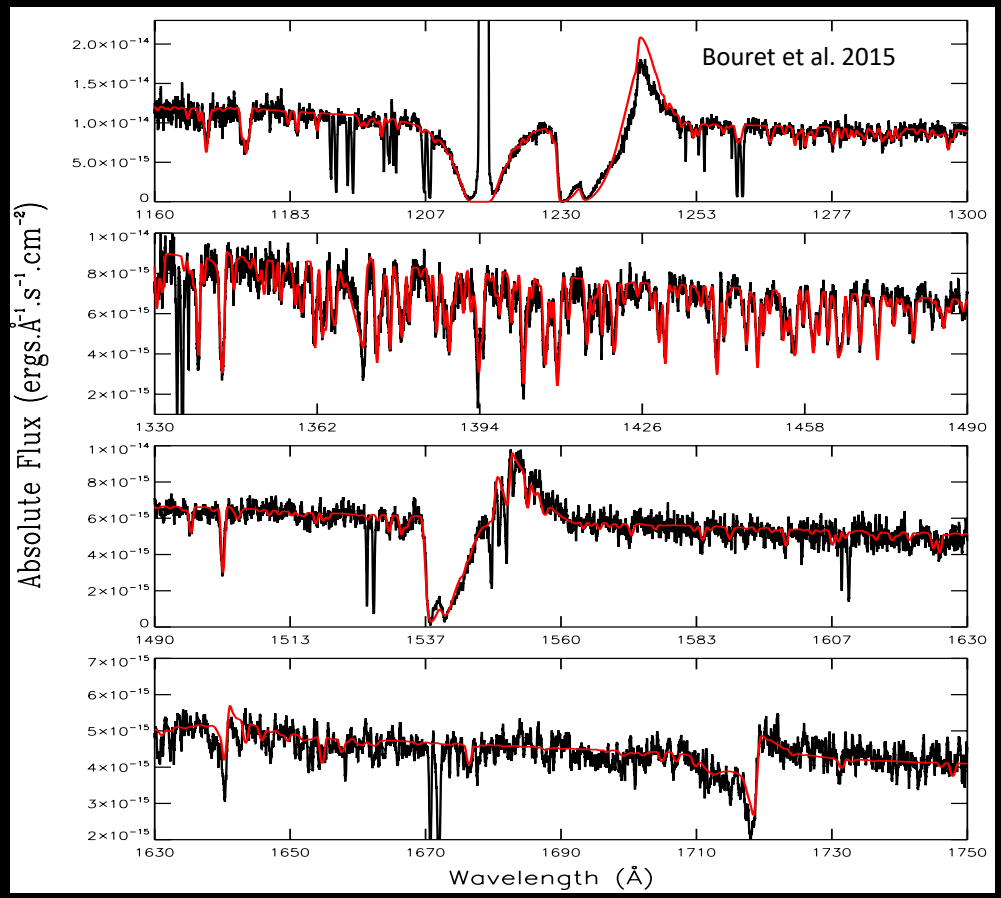


Garcia et al 2014

Need UV for Mdot, v_∞ and Fe/H

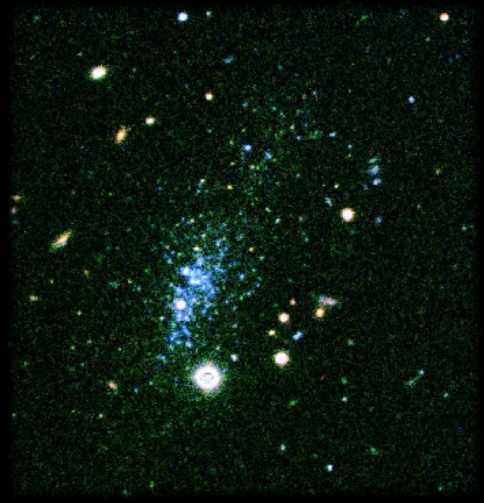
Fe/H of IC1613 < SMC → $z \sim 2$
Sub-solar [α/Fe] of −0.10

high R (5-7 orbits/star) → (3 stars)

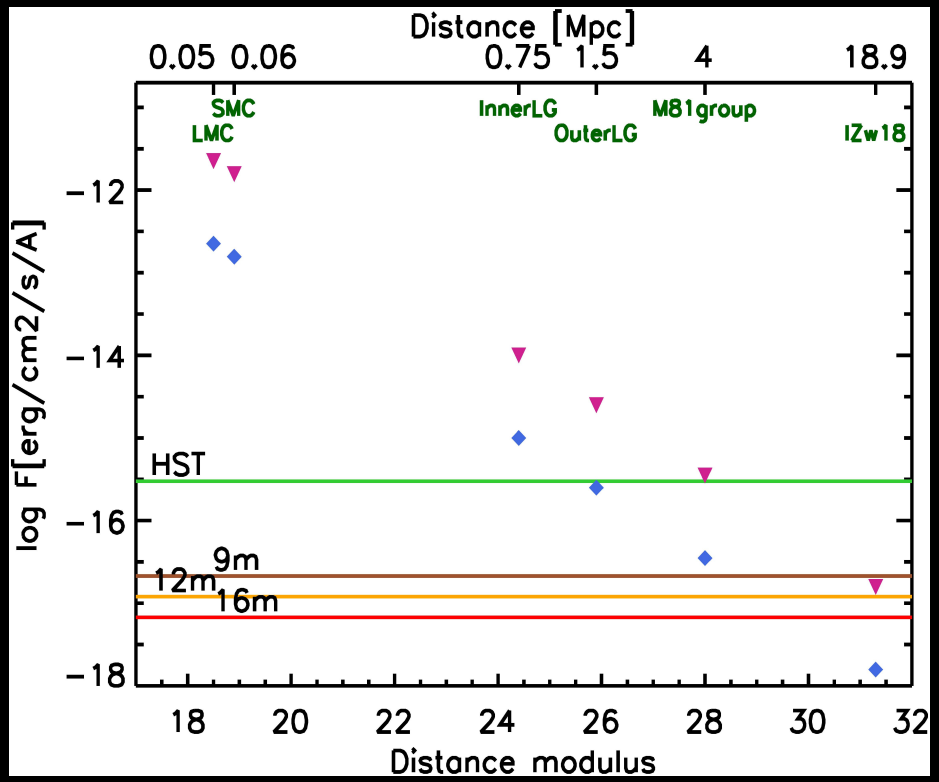


Massive stars far beyond the Local Group

Leo P ($Z \sim 0.1 Z_\odot$ 1.65 Mpc)→ At least 50ks exposures for *HST*-COS data per star (14 orbits)



Goal: UV spectra of individual massive stars up to I Zw 18 (18 Mpc, $Z \sim 0.03 Z_\odot$) to test predictions at very low Z



← **LUVOIR + LUMOS**

POLarimètre en Lumière Uv eXtrême: POLLUX

LESIA (C.N.), LAM (JCB), IRAP (A.L.A.)

High-resolution, FUV to Optical, Spectropolarimeter

Spectral Resolving power: R = 120,000

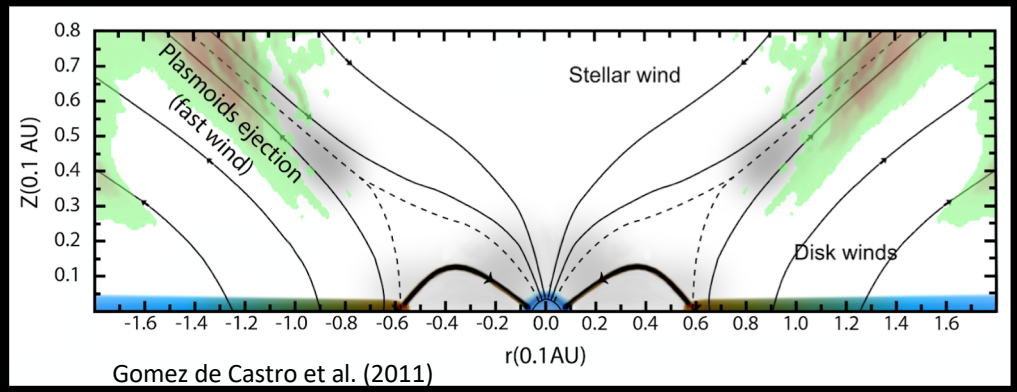
Spectral Bandpass: 98 – 390nm

Full wavelength range in two shots

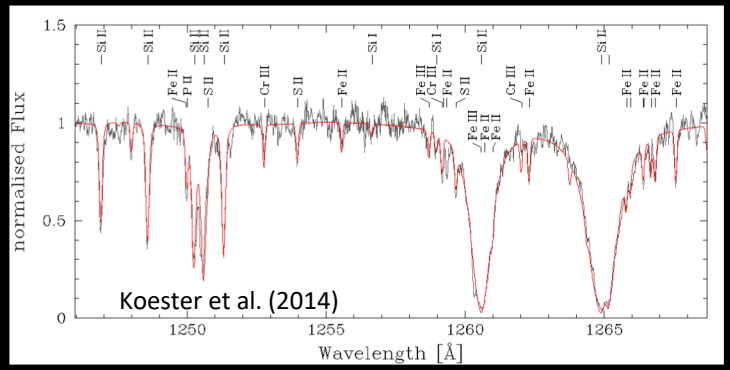
Circular (V) and linear (QU) polarization

Mode on/off for the polarimeters

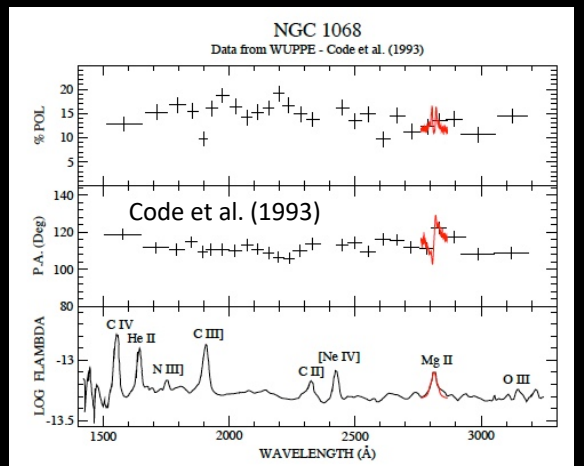
Aperture size: 0.03’’



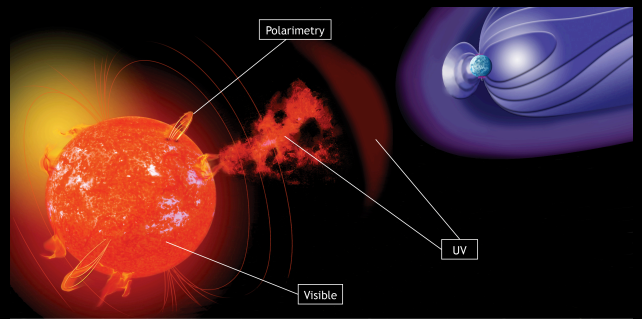
Gomez de Castro et al. (2011)

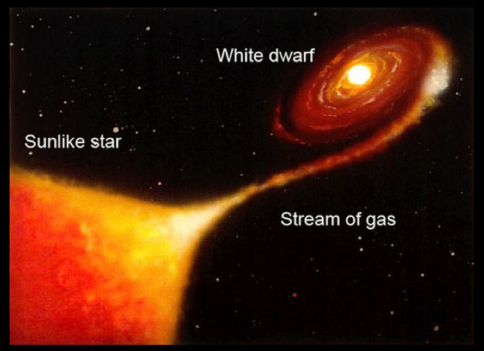


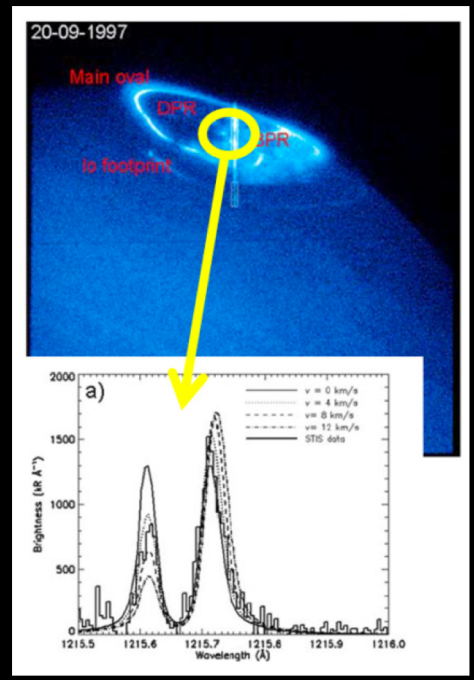
Koester et al. (2014)



Code et al. (1993)







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LUVOIR

LUVOIR

Large UV/Optical/IR Surveyor

Science Design Team Tools Events Participate Resources Technology Press

Participate

Details on meetings can be found on the events page.

Working Groups

We welcome participation in any of the LUVOIR working groups. To sign up, please contact the working group leads.

- Cosmic Origins Science:
  Leads: John O'Meara (jomeara@smcvt.edu) and Jane Rigby (jane.r.rigby@nasa.gov)
- Exoplanet Science:
  Leads: Mark Marley (mark.s.marley@nasa.gov) and Avi Mandell (avi.mandell@nasa.gov)
- Solar System Science:
  Leads: Walt Harris (wharris@lpl.arizona.edu) and Geronimo Villanueva (geronimo.l.villanueva)
- Communications:
  Leads: Debra Fischer (debra.fischer@yale.edu) and Shawn Domagal-Goldman (shawn.goldman@nasa.gov)
- Simulations:
  Leads: Jason Tumlinson (tumlinson@stsci.edu) and Aki Roberge (aki.roberge@nasa.gov)
- Technology:
  Leads: David Redding (david.c.redding@jpl.nasa.gov) and Matt Bolcar (matthew.bolcar@nasa.gov)

NASA Goddard SPACE FLIGHT CENTER

Curator: J.D. Myers
NASA Official: Phil Newman

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Design Team Tools Events Participate Resources Technology Press

Tools

This page links to performance simulation and visualization tools for the LUVOIR mission, a future ultraviolet / optical / near-infrared observatory concept.

These widgets are experimental. If they are not working, email Jason Tumlinson (STScI). For the Planetary Spectrum Generator, email Geronimo Villanueva (GSFC).

LUVOIR Science Case Template

Word document to describe a LUVOIR science case.

Coronagraphic Spectra of Exoplanets

Simulate optical/near-IR reflection spectra of various exoplanets with realistic noise.

Multiplanet Yield Tool

Tool for visualizing yields of observed exoplanets (of various types) as function of basic mission parameters.

Planetary Spectrum Generator

Advanced tool for simulating spectra of Solar System bodies (with LUVOIR and other telescopes).

HDI Photometric ETC

Basic exposure time calculator for optical photometry in multi-band images.

LUMOS Spectroscopic ETC

Simple exposure time calculator for UV spectroscopy.

UV MOS Visualizer

See the impact of UV multi-object spectroscopy on the study of stellar clusters and their feedback.

High-Resolution Imaging

Examples of astronomical objects viewed with different sized telescopes.

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Curator: J.D. Myers
NASA Official: Phil Newman

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