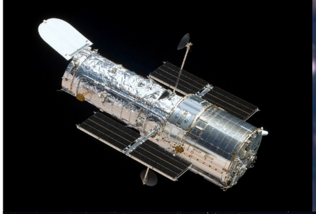
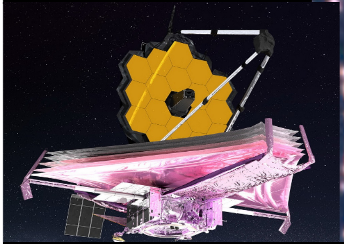
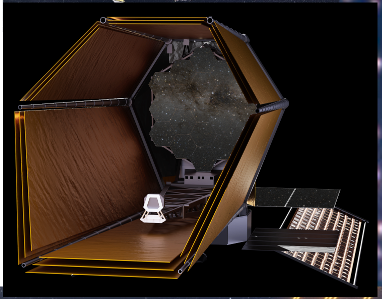
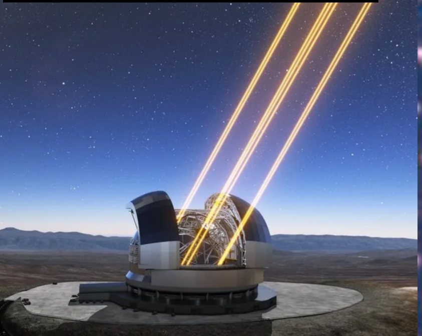





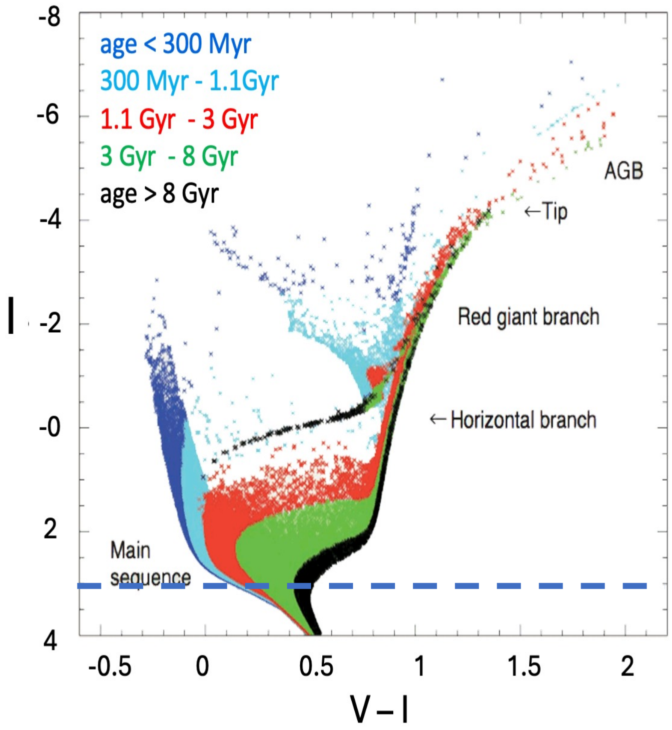
Tracing galaxy evolution with resolved stars: the HWO perspective

Francesca Annibali
(INAF – OAS Bologna)

Shaping the Italian contribution to HWO
July 10-11 2025
Università La Sapienza - Rome

Tracing galaxy evolution with resolved stars

Color-magnitude diagrams are powerful tools to age-date stars



I=28,
1 Mpc

Tracing galaxy evolution with resolved stars

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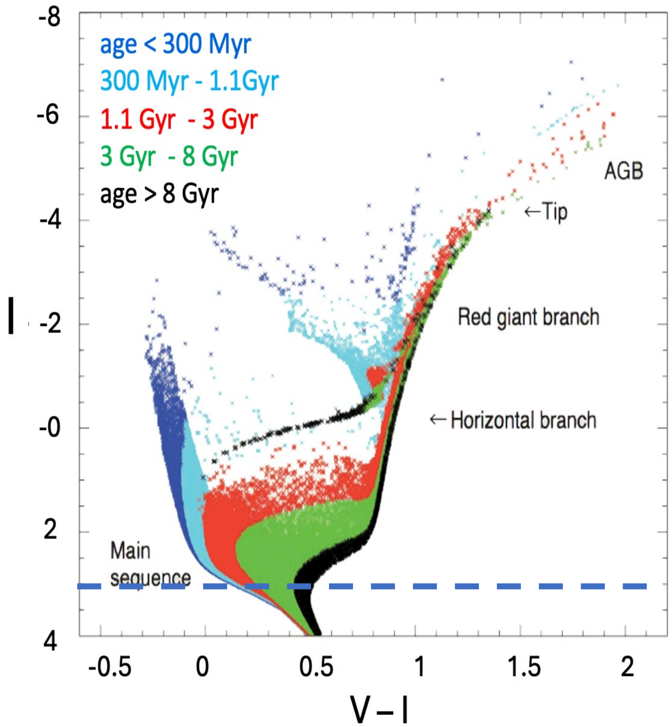
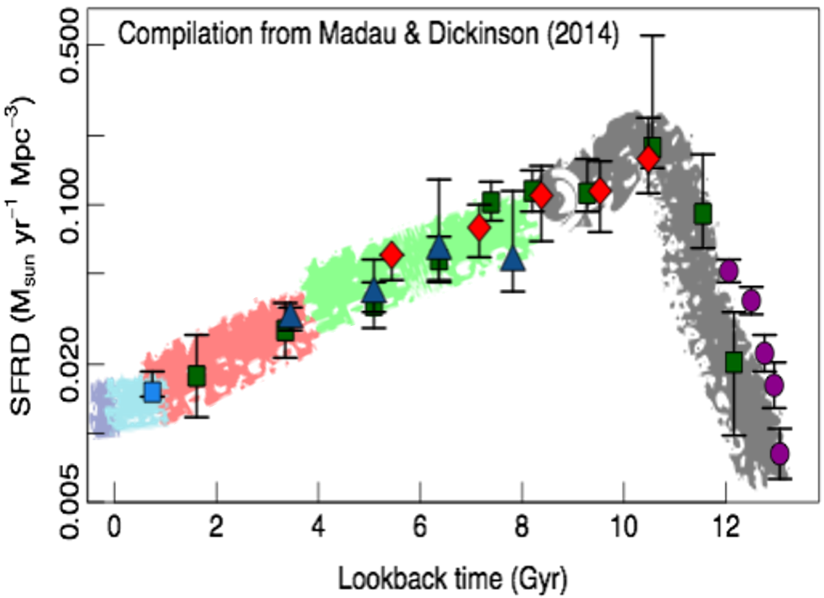


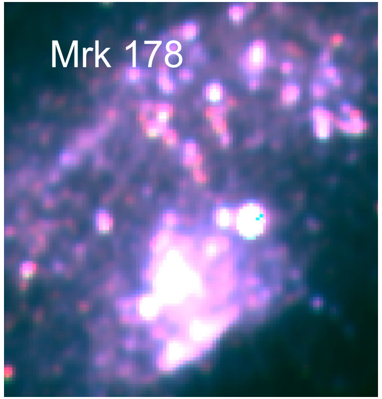


The deeper the CMD,
the higher the *z* we can probe

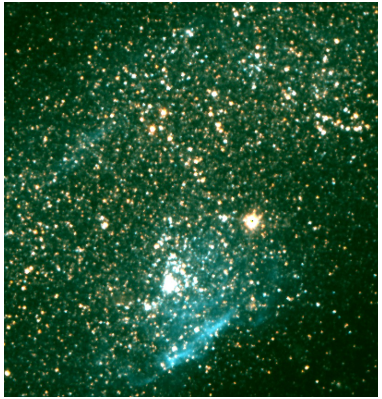
Tracing galaxy evolution with resolved stars

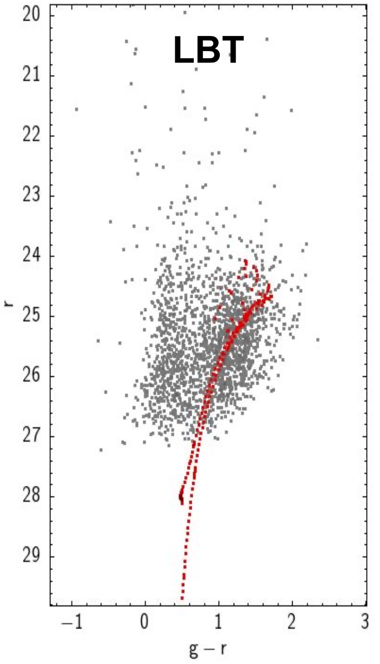
The importance of spatial resolution

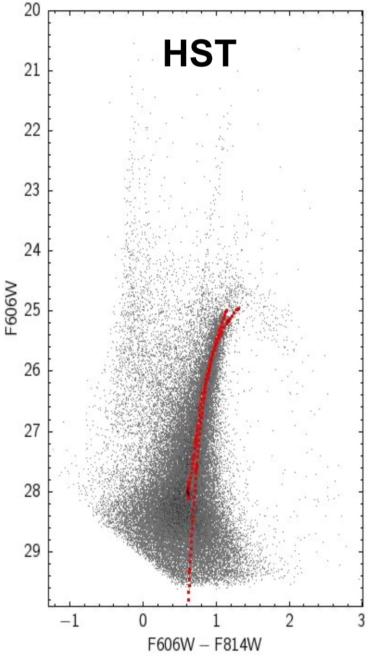
LBT (8.4 m)
seeing limited



HST (2.4 m)
diffr. limited

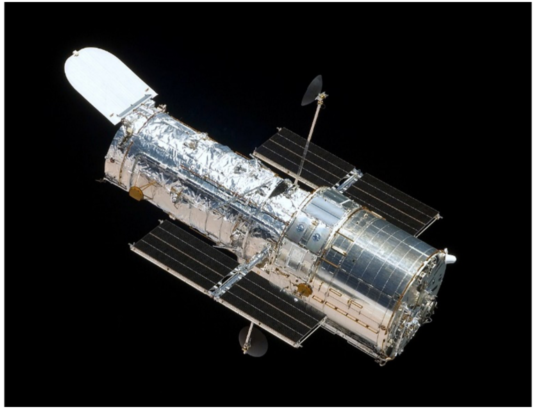


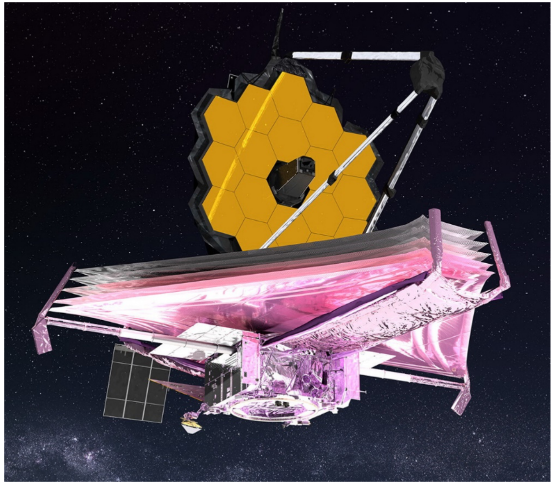




Resolving individual stars to deep magnitudes requires **high angular resolution** in crowded fields!

Spatial resolution in context





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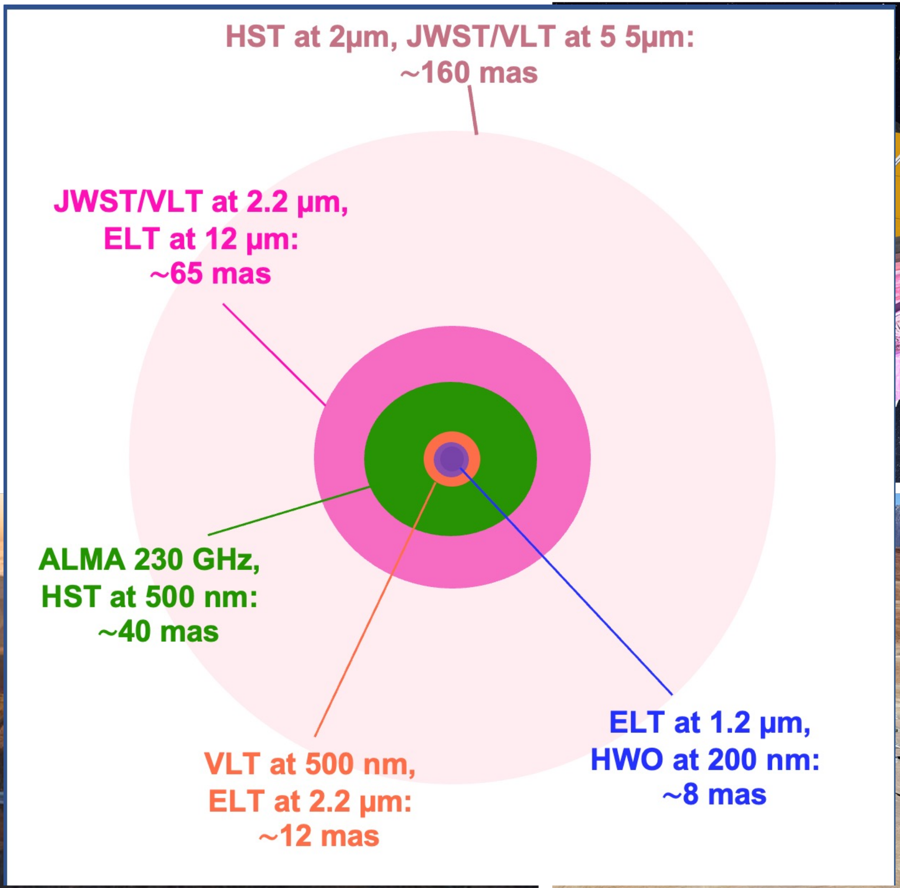
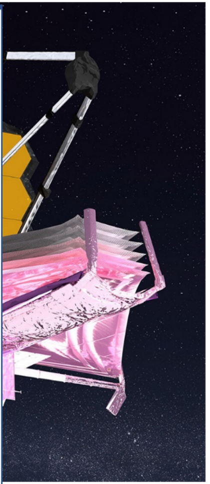
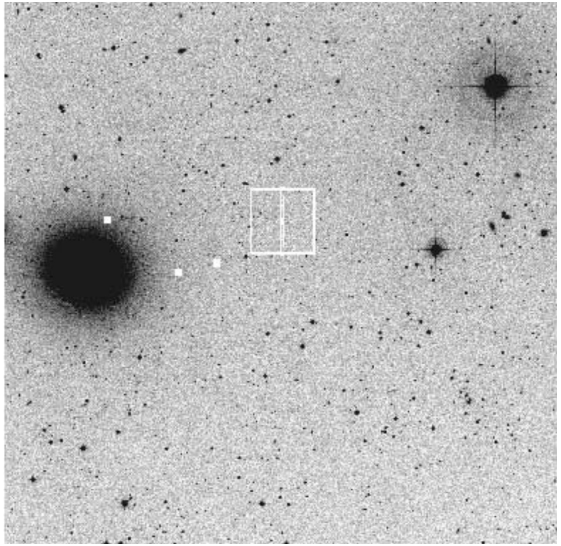




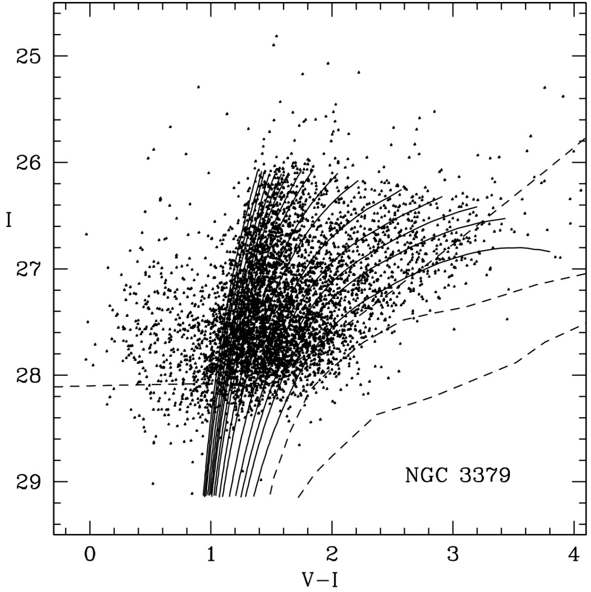
Reaching the oldest stellar populations in giant E galaxies

- From JWST, massive quiescent galaxies at 3<z<5 (i.e. Carnall+24)
- No example of giant Es in the LG
- Cen A at 3.8 Mpc, peculiar/merging E/S0
- Nearest "classical" giant E is NGC3379 at 10 Mpc

Harris + 2007, (NGC 3379 halo)
HST, 38 k sec in V + 22 k sec in I



RGB: ages within (2-13) Gyr.
HB expected at I~30!



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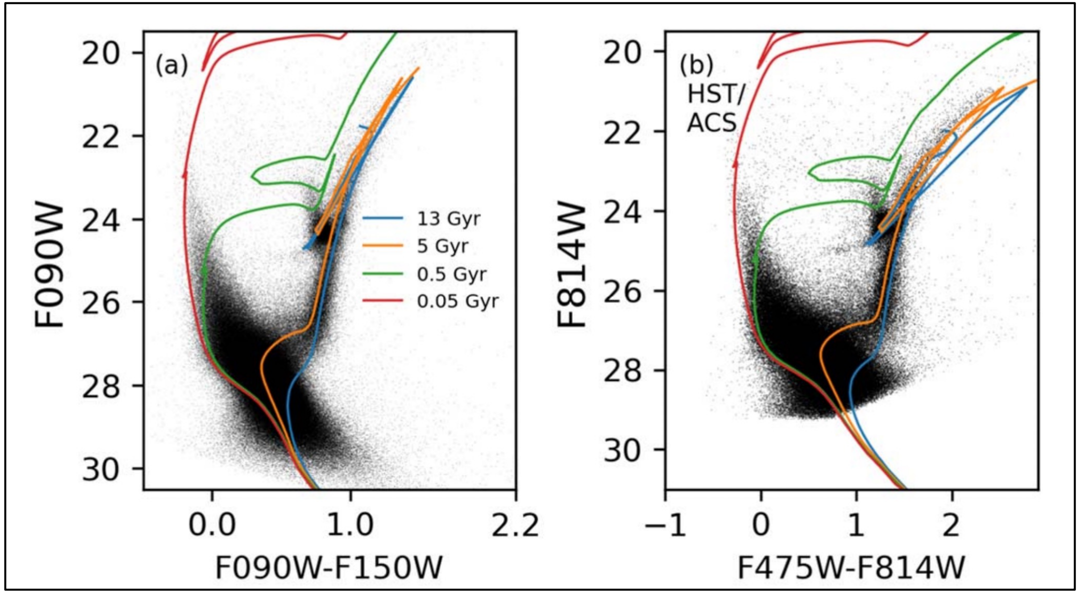
Weisz et al. 2023, WLM (D=0.9 Mpc)

JWST vs HST



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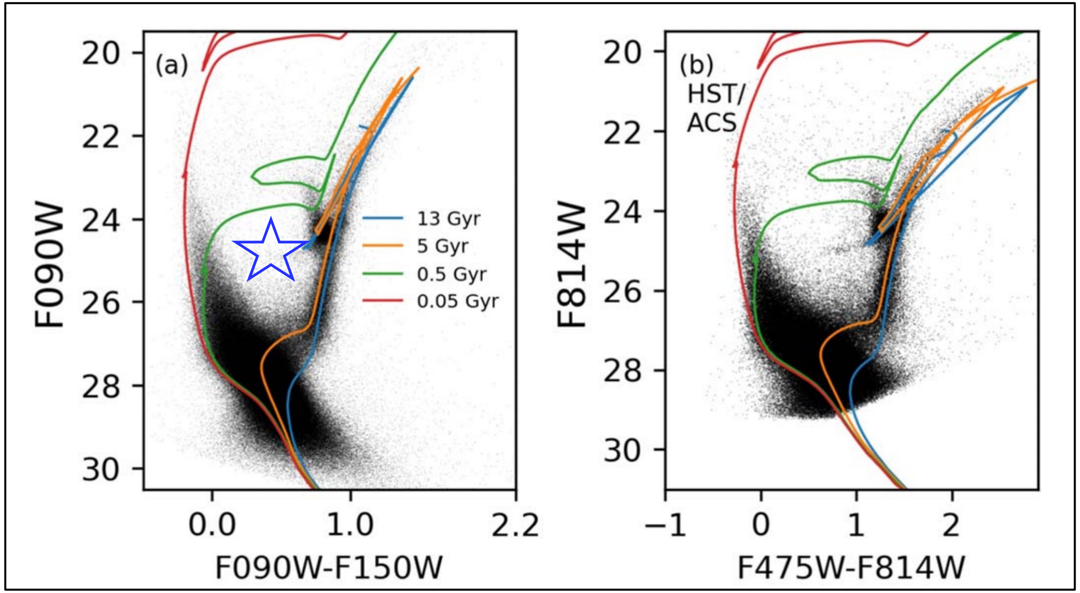

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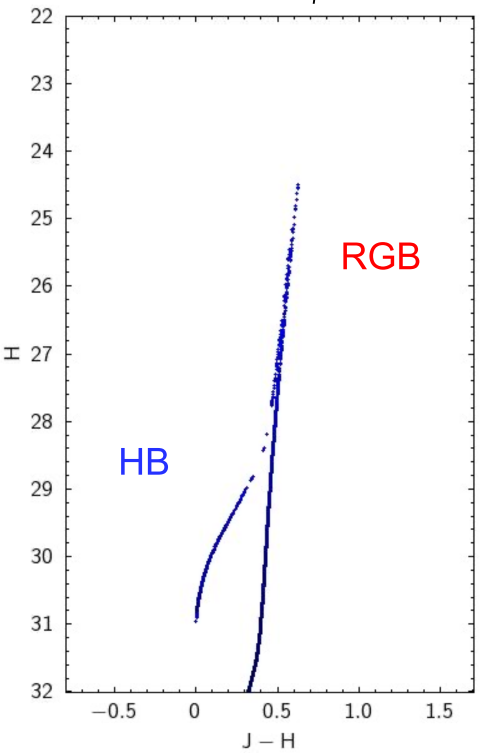
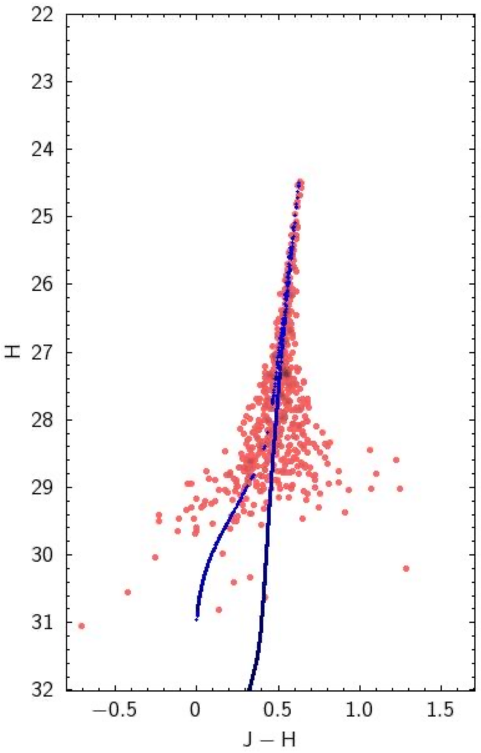
PARSEC SSP, 12 Gyr, Z=0.0001, D=10 Mpc



M&M simulation, ~7h per band



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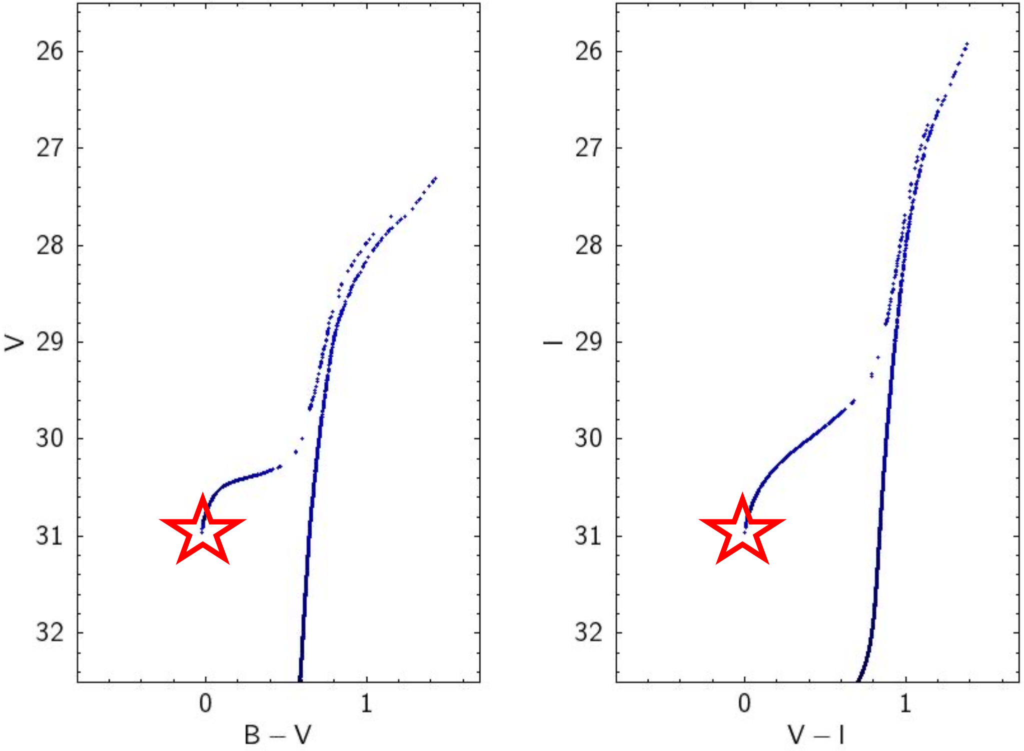
- With HWO, HB detected in[1]
  V, I with ~1+1 h (FWHM ~0.02", 0.03")
  B, V with ~2+1 h (FWHM ~0.017", ~0.02")

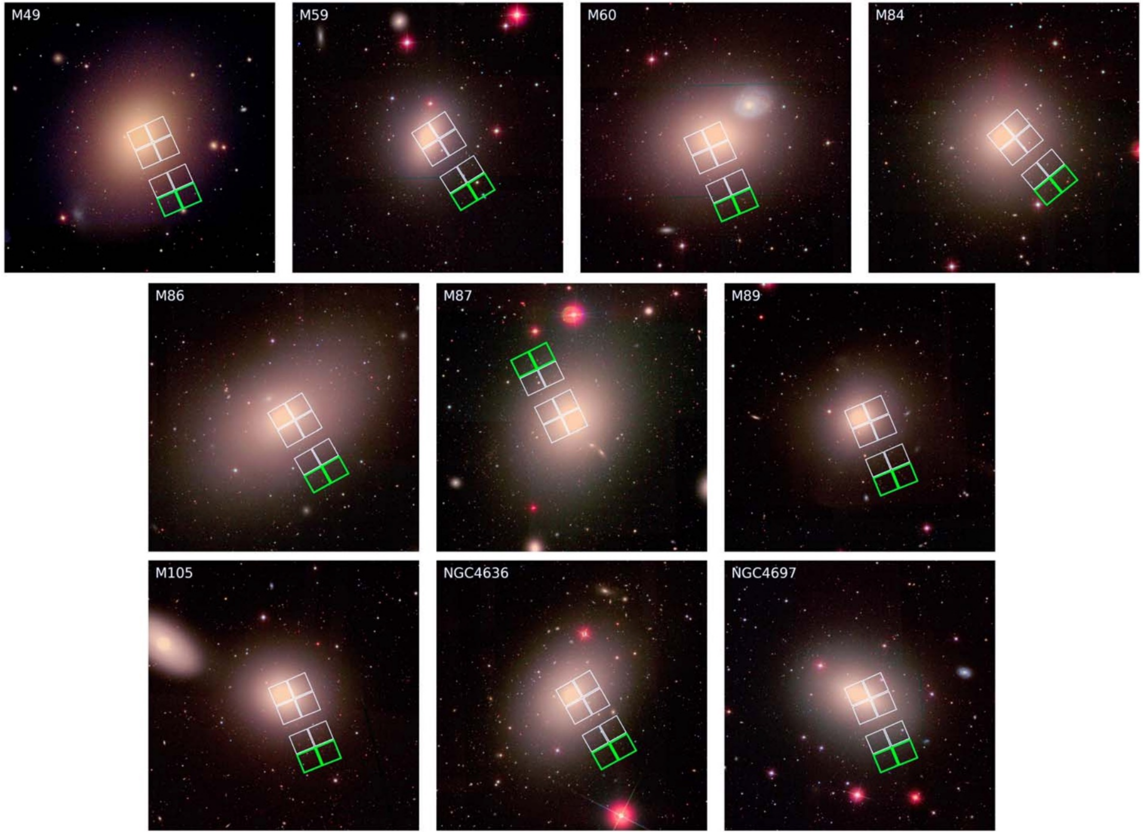
PARSEC SSP, 12 Gyr, Z=0.0001, D=10 Mpc



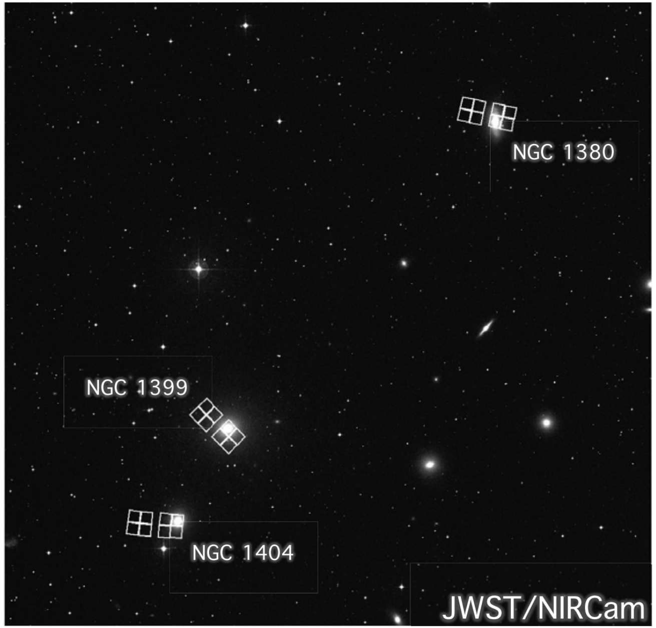
[1]ETC https://hwo.stsci.edu/camera_etc.

Many giant Es in Virgo Cluster!

10 E galaxies in **Virgo** (Anand et al. 2025)



3 E galaxies in **Fornax** (Anand et al. 2024)



Anand et al. 2025

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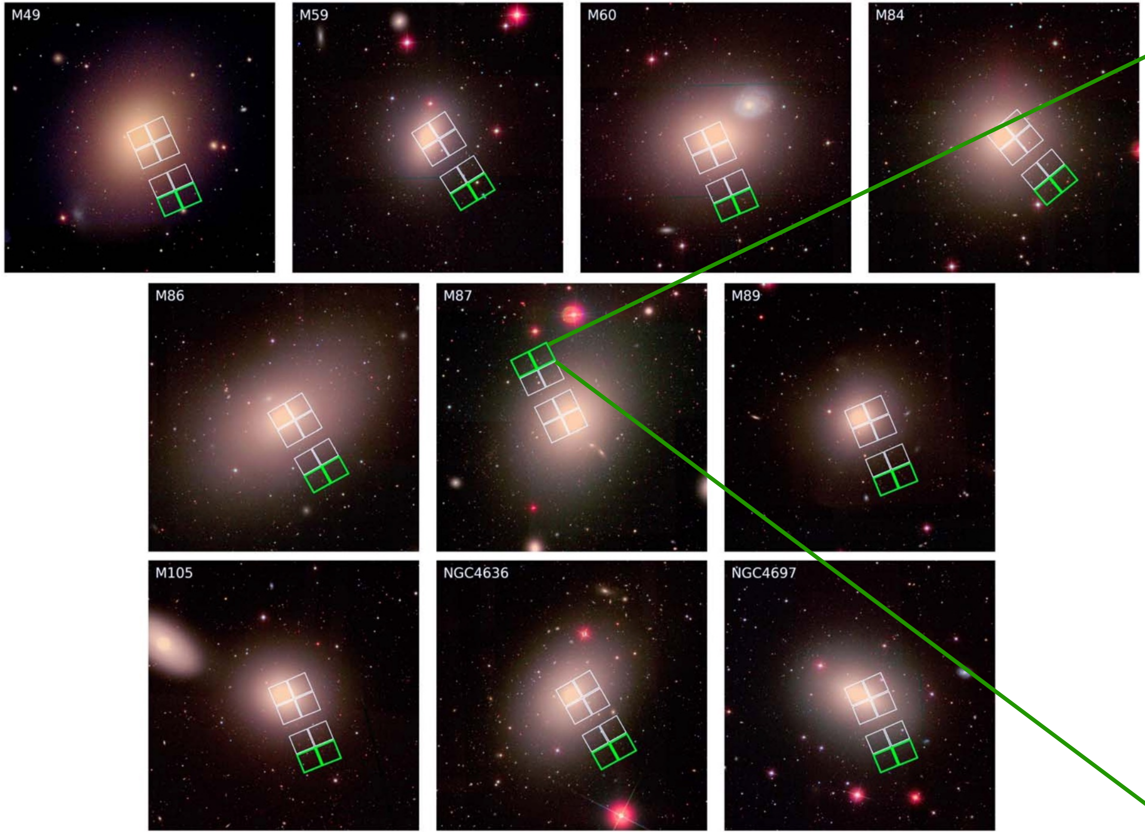
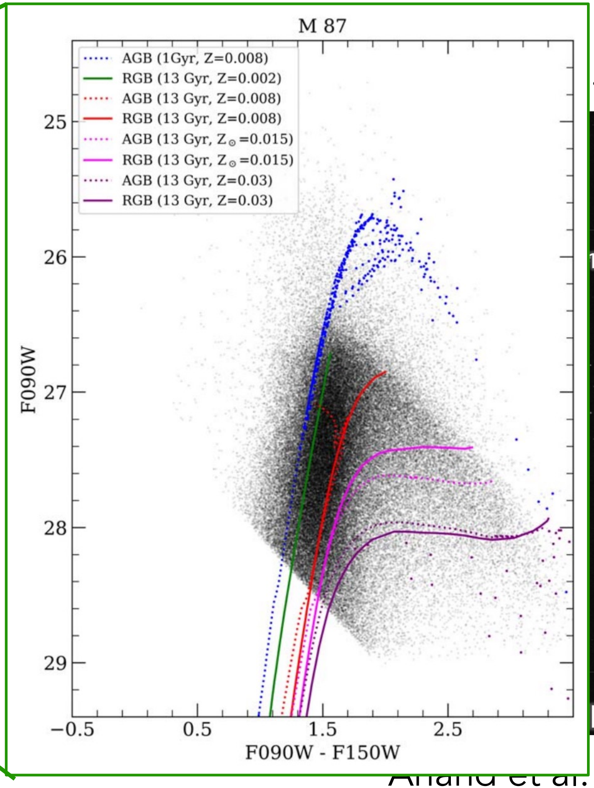
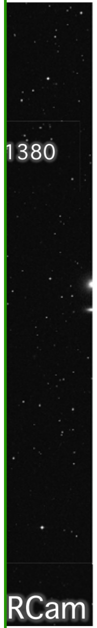


RGB stars resolved only in outer field



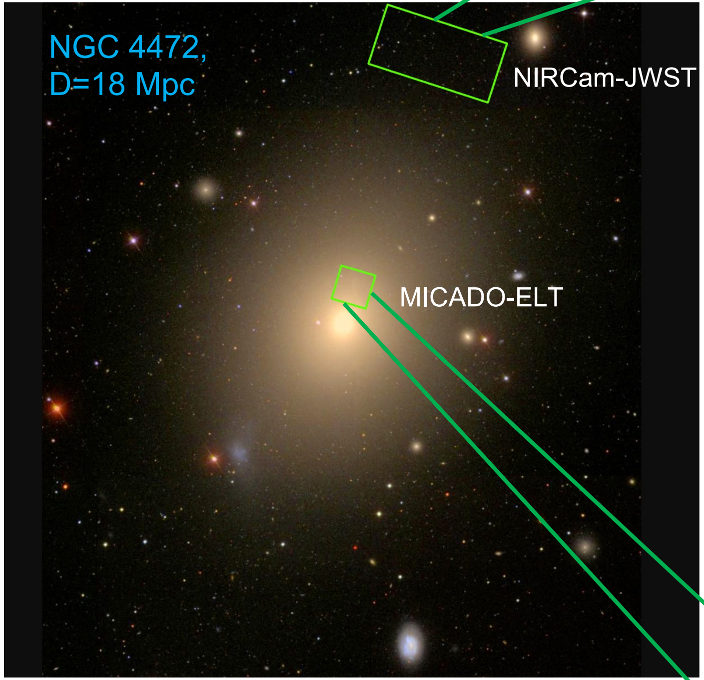
. 2024)

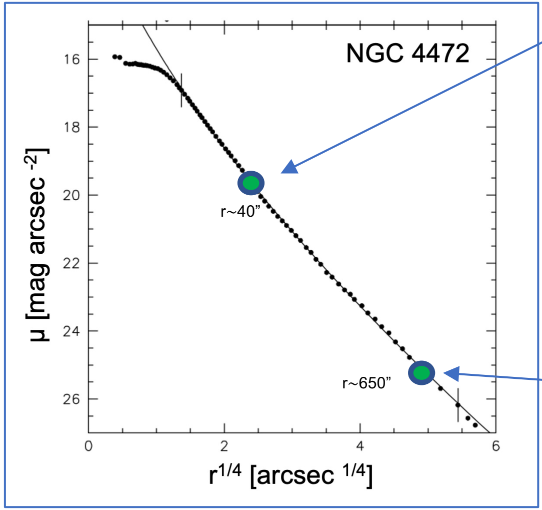


Anand et al. 2025

Accessing inner regions of Virgo Es with M&M@ELT

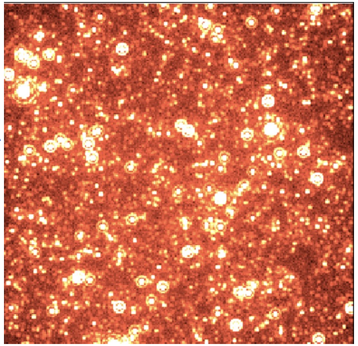
Large FoV,
outer, low-crowding regions



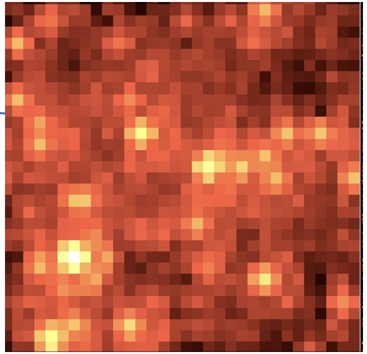


Small FoV,
inner, high-crowding regions

Simulated images

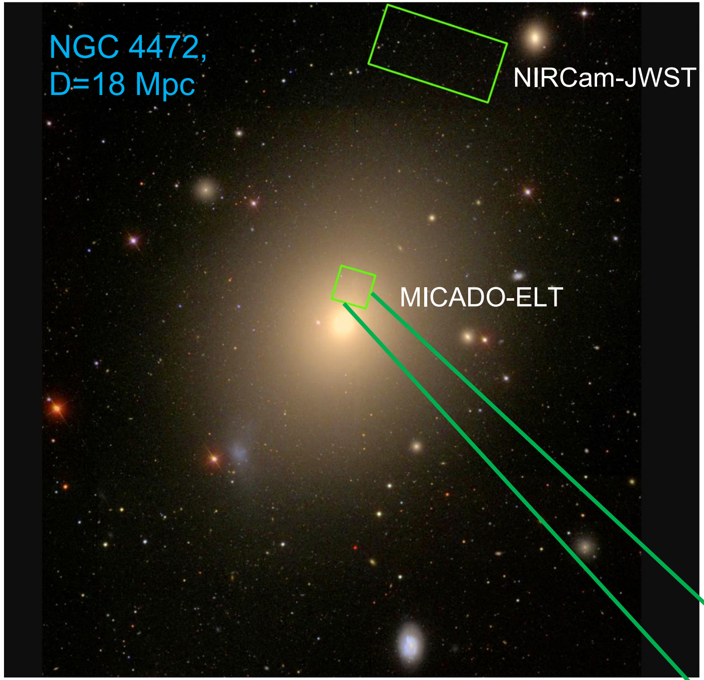


μ = 19.6
MICADO-ELT



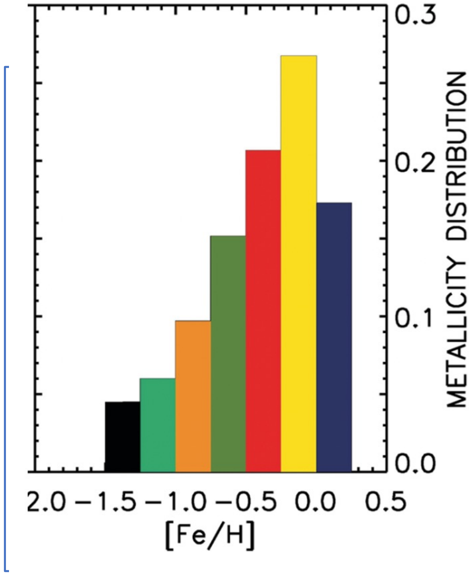
μ = 25.2
NIRCam-JWST

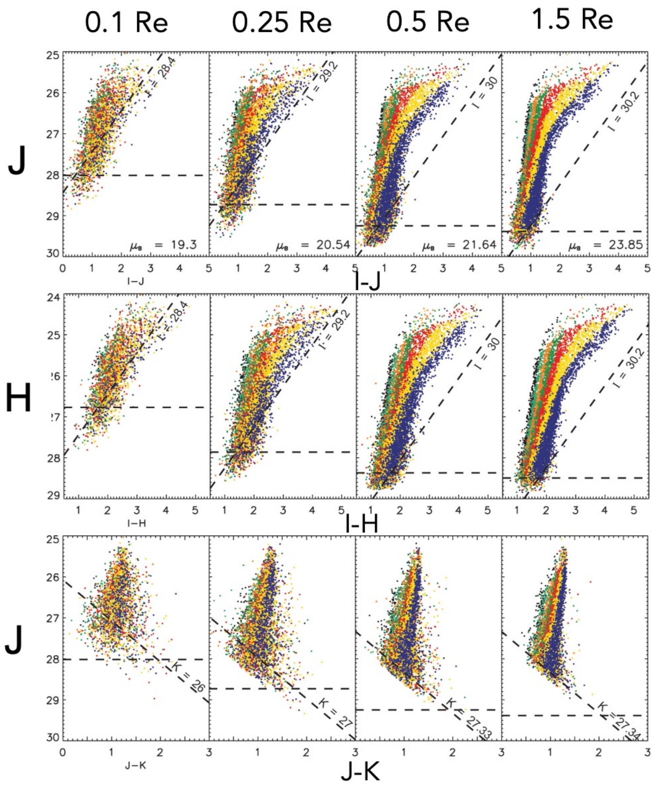
Accessing inner regions of Virgo Es with M&M@ELT



Deriving the metallicity distribution with RGB stars

Schreiber et al. 2014





Small FoV,
inner, high-crowding regions

Reaching the HB at 18 Mpc with HWO

PARSEC SSP, 12 Gyr, Z=0.0001, D=18 Mpc

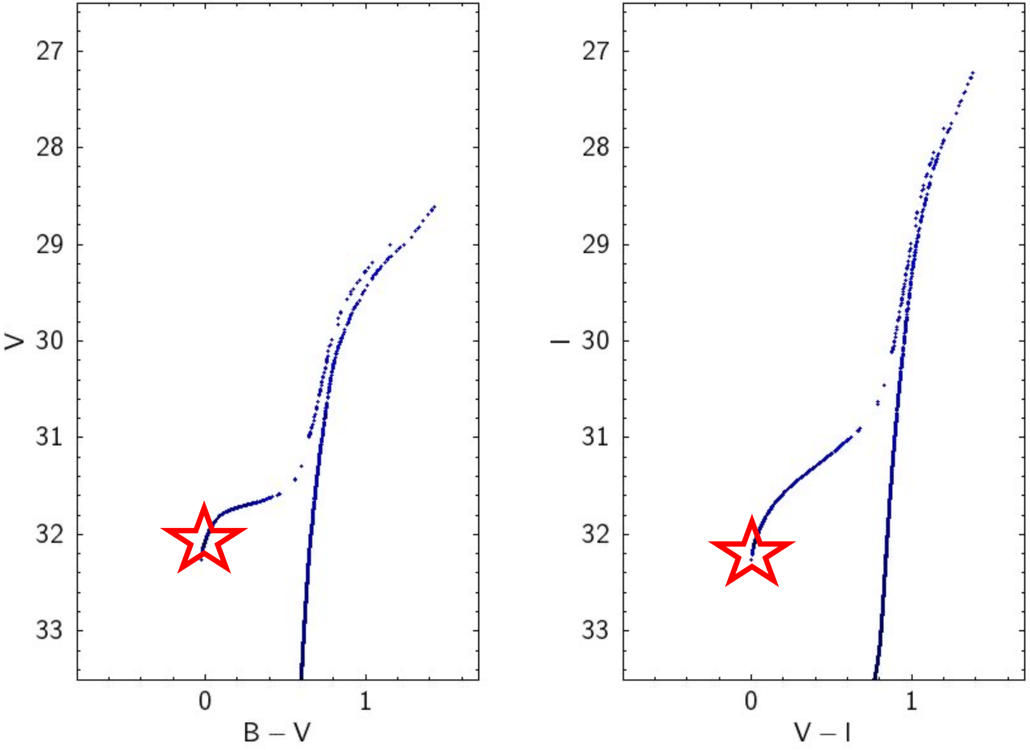
HB reached at 18 Mpc with[1]:

~4 h in V
~4.5 h in I
~7 h in B

Not limited to giant Es, but:

- Galaxies of all morphological types
- IZw18, a unique place to study SF in primeval conditions

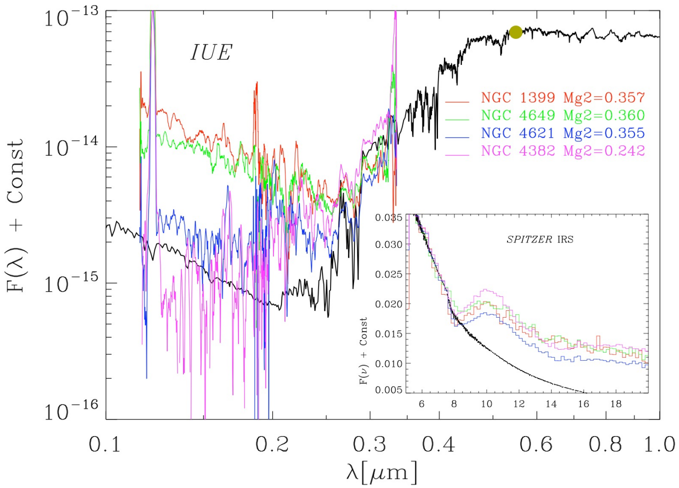
[1]ETC https://hwo.stsci.edu/camera_etc.

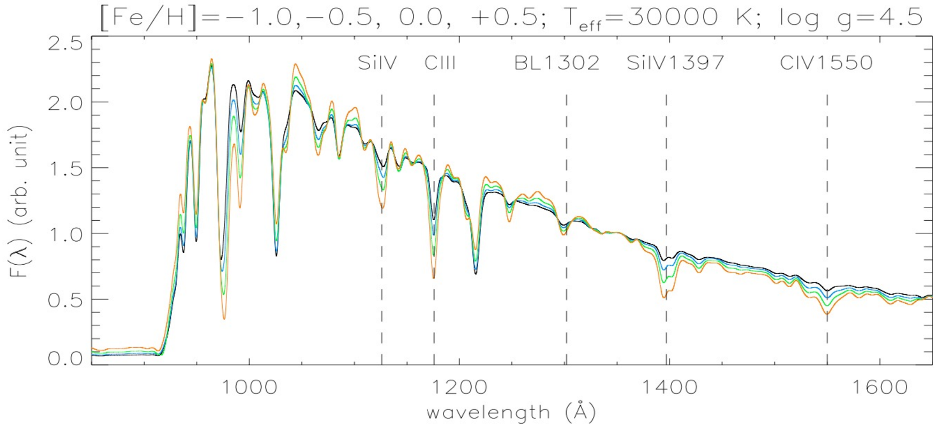


HWO & the origin of the UV upturn in Es

- UV upturn in Es at **λ~2000 Å**
- Correlates with **σ** and metallicity
- Origin still debated, a possibility is an **old, hot population of EHB stars:**

a) in the metal poor tail of the MDF;
b) with high Z and high He content;
c) with enhanced mass loss at high Z:
d) He-enriched like in GCs



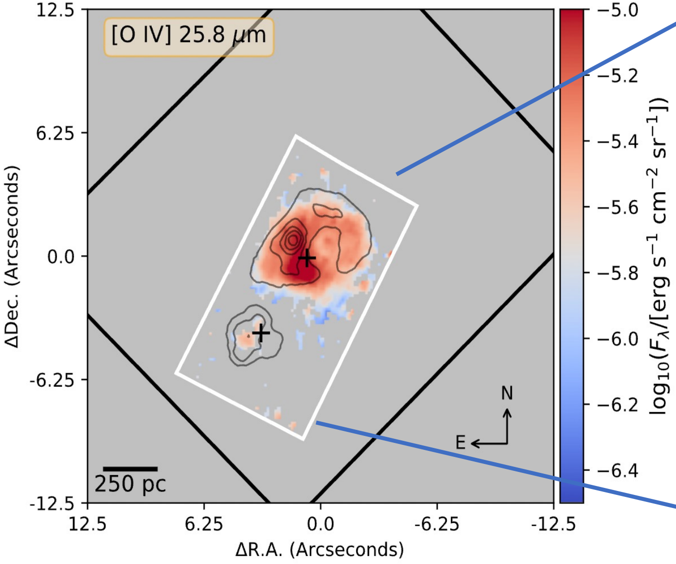


UV spectroscopy could constrain the metallicity of the population responsible for the UV upturn

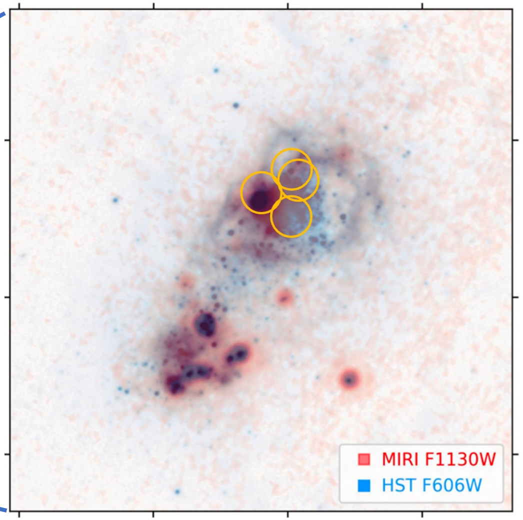
Massive stars in extremely metal poor environments

BCD IZw18, Z~2-3 % solar, D=18 Mpc

[OIV] map



[NeV] λ14μm detections



First JWST **[NeV]** detection in IZw18 !

[NeV] IP = 97 eV
[OIV] IP = 55 eV
HeII IP = 54 eV

Very hard Radiation Field, also seen in LyC leakers

Possible ionization mechanisms:

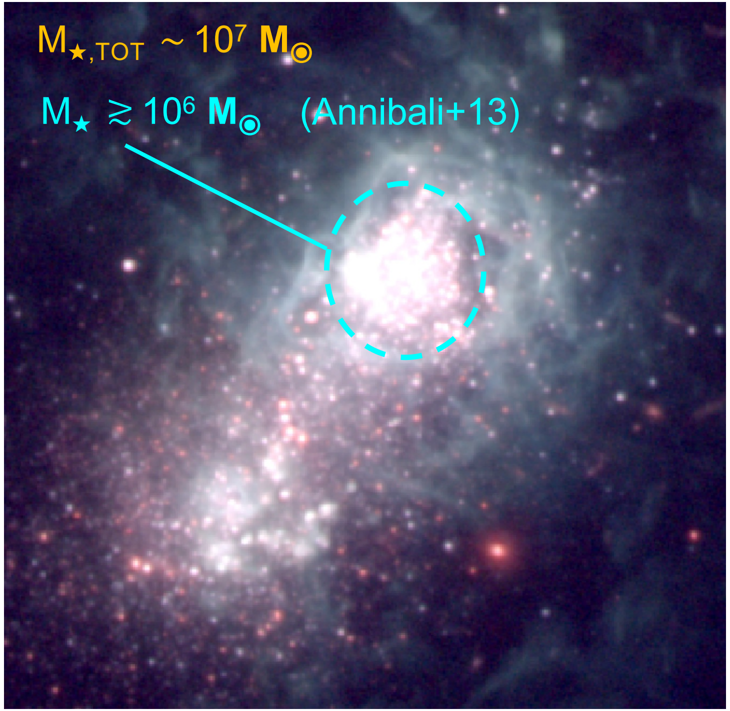
- ~~AGN~~
- Very metal poor supermassive stars (Pop III)
- Metal poor stars + ULX
- X-rays from star cluster winds

Hunt et al. submitted
Vaught et al. submitted
Arroyo-Polonio et al. (2025)
See also Mingozzi et al. (2025) for [NeV] in SBS0335-052

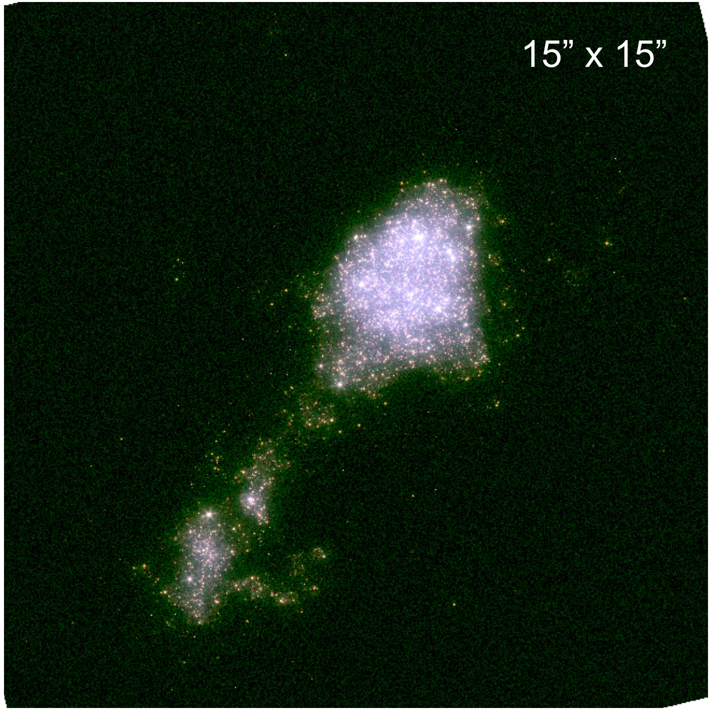
Massive stars in extremely metal poor environments

BCD IZw18, Z~2-3 % solar, D=18 Mpc

IZw18, HST ACS
F555W, F606W, F814W



IZw18, ELT, M&M simulation
J, H, K

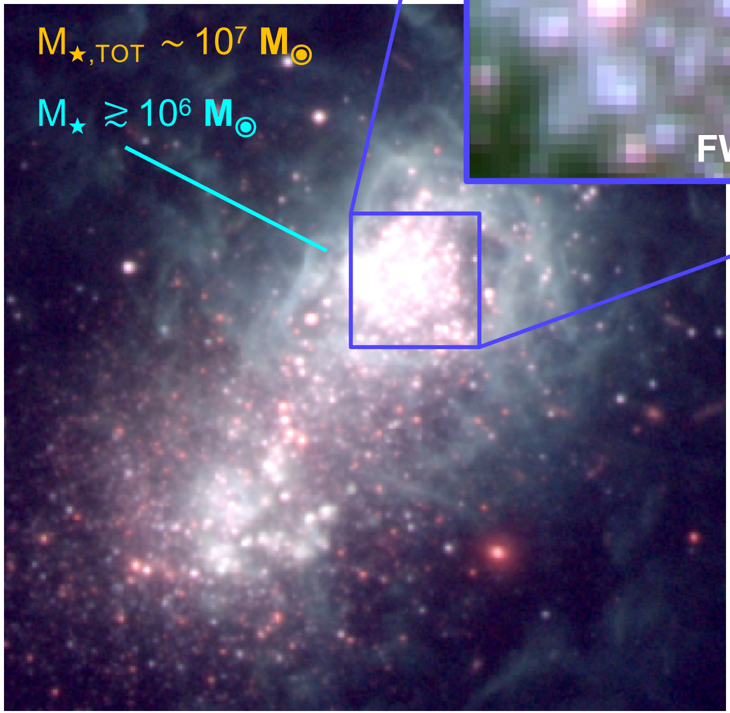


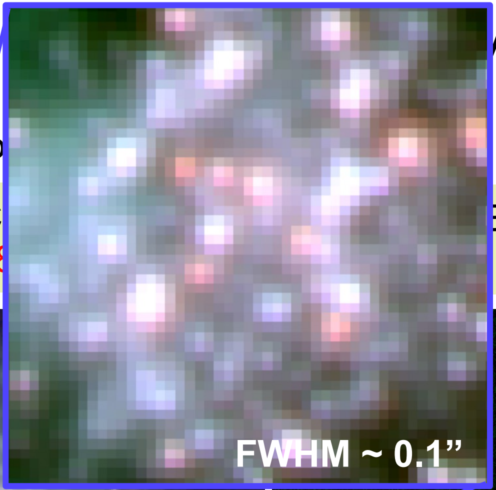
Massive … metal poo

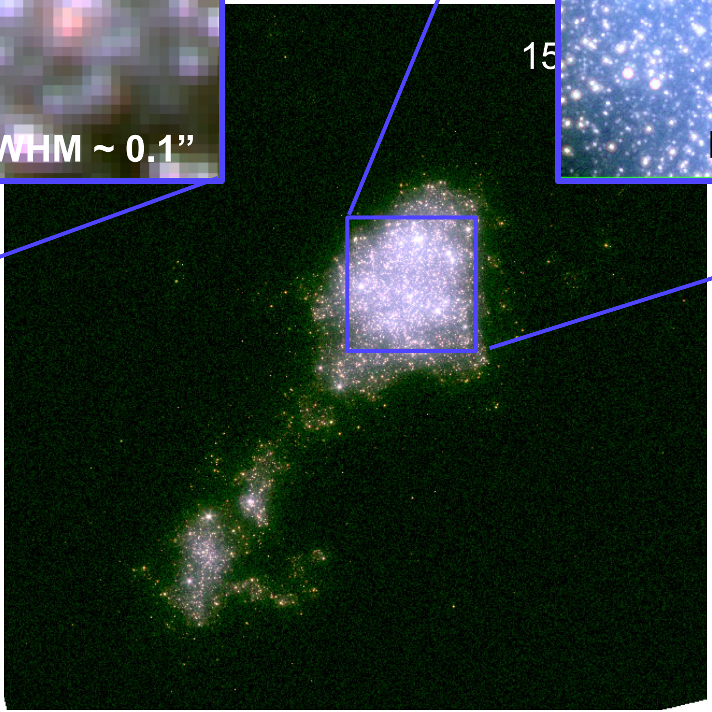
BCD IZw18, Z~2-3 % so

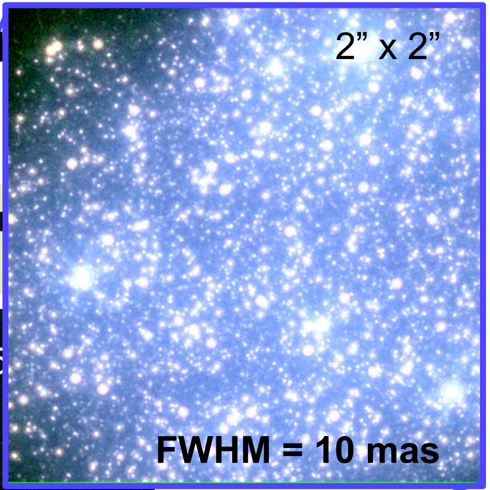
IZw18, HST AC
F555W, F606W, F8

ELT, M&M simulatio
J, H, K









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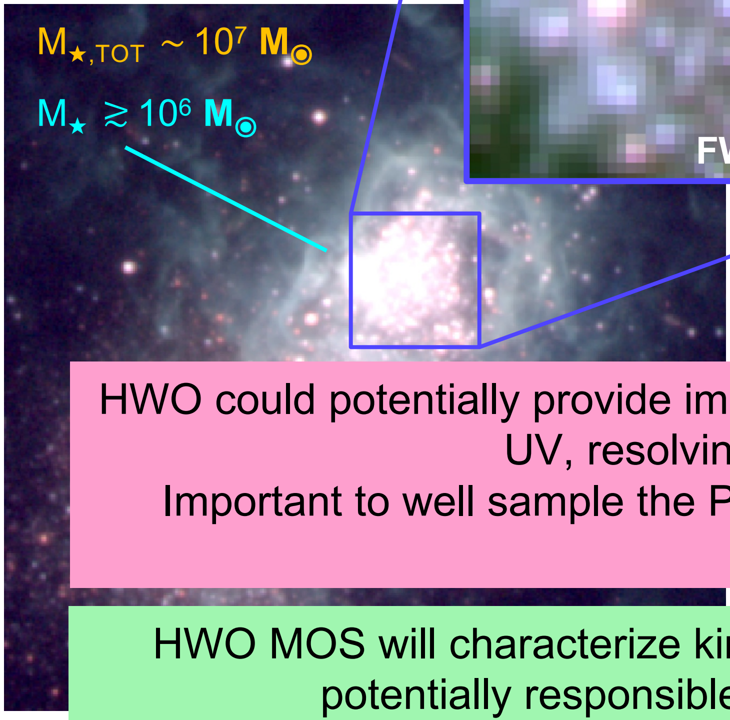
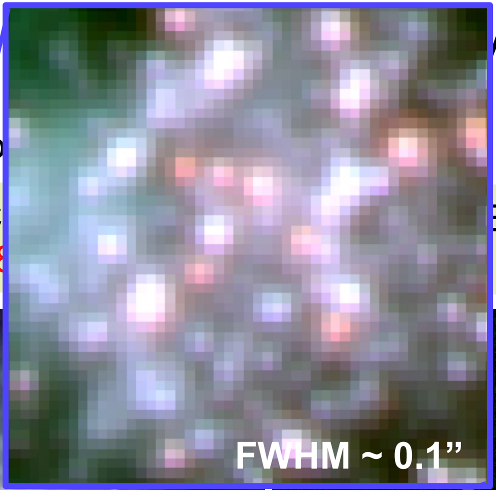
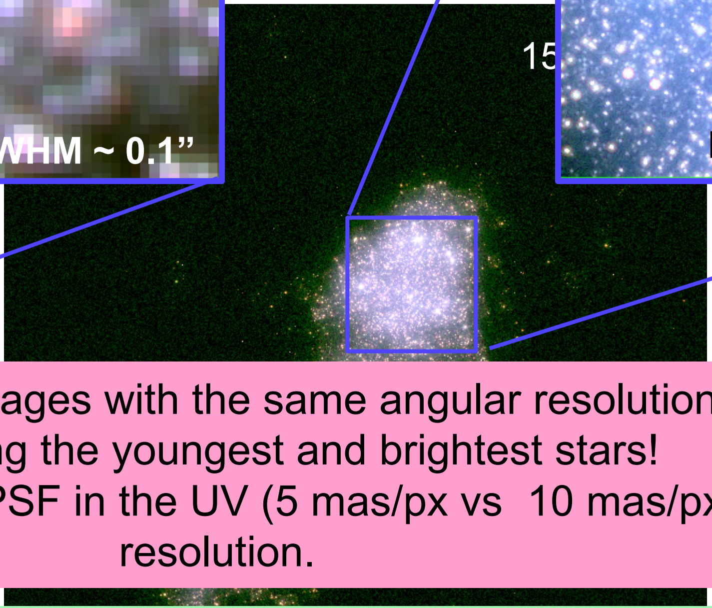
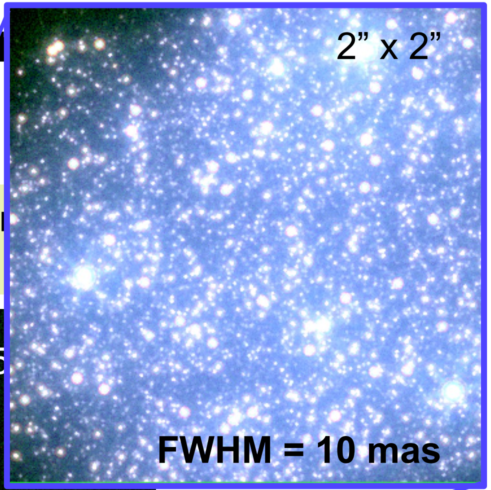
IZw18, HST AC…
F555W, F606W, F8…

…ELT, M&M simulation
J, H, K









HWO could potentially provide images with the same angular resolution of M&M but in the UV, resolving the youngest and brightest stars!
Important to well sample the PSF in the UV (5 mas/px vs 10 mas/px?) to maximize resolution.

HWO MOS will characterize kinematics of the ionized gas / outflows / superbubbles, potentially responsible for hard RF and escape of ionizing photons

Conclusion

HWO could provide major progress in:

- Through resolved-star CMDs as deep as the HB, provide the detailed SFH of massive Es since the earliest epochs
- Shed light on the nature of the UV upturn in massive E galaxies
- Constrain the ancient SFH of highly unevolved systems, like IZw18
- Constrain the IMF in the high mass range at very low Z
- Understand feedback from very metal poor, high mass stars (hard RF, escape of ionizing photons…)

Fundamental to have the highest possible spatial resolution!