

# Observational Cosmology with Surface Brightness Fluctuations

From Euclid to AO-assisted data



Osservatorio Astronomico d'Abruzzo

**Michele Cantiello**

In Collaboration With

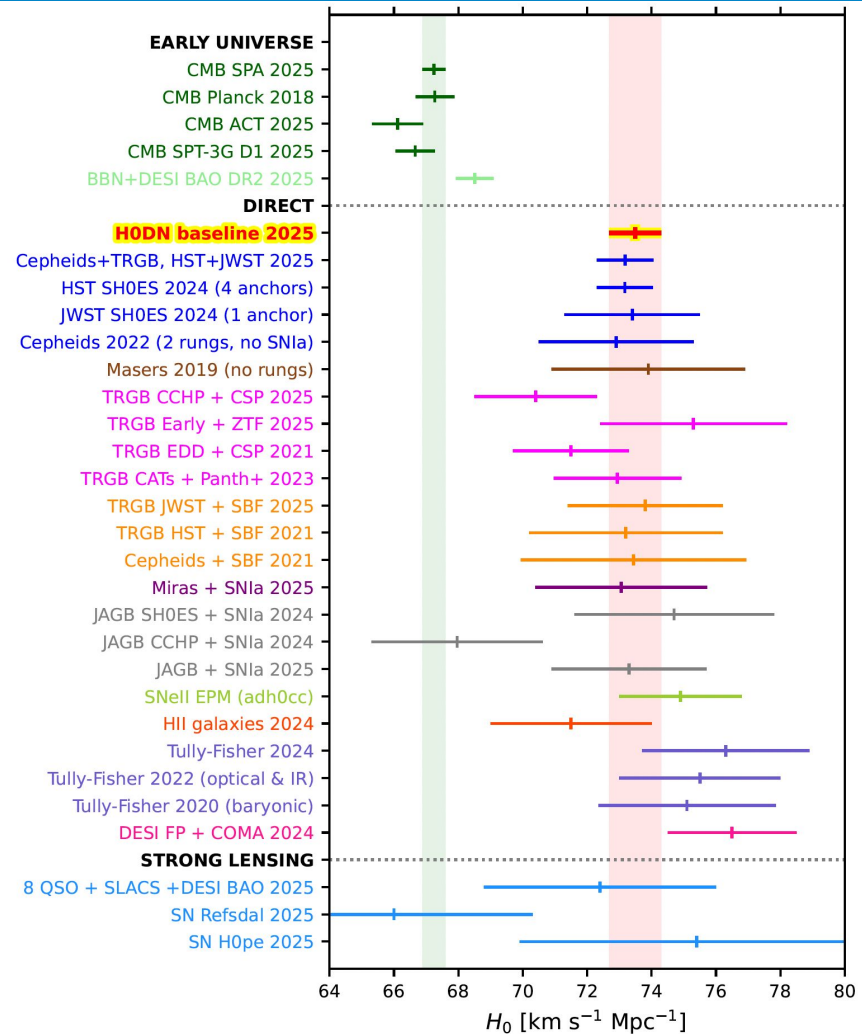
**R. Habas** (INAF) **G. Riccio** (INAF) **M. Mirabile** (INAF/ESO)  
**J. Blakeslee** (NOIRLab, AZ) **E. Brocato** (INAF) **G. Di Rico** (INAF)  
**J. Jensen** (UVU, UT) **G. Raimondo** (INAF)

# Hubble Tension

*"...increasingly precise measurements of  $H_0$  have revealed a striking and persistent discrepancy between its value inferred from observations of the early Universe, such as the CMB, and its value measured directly in the local Universe using distance ladder methods... known as the "Hubble tension," has persisted for a decade, and it exceeds the threshold for a statistical fluctuation and has withstood extensive scrutiny of both observational data and analysis techniques"*

[HODN Collaboration: Stefano Casertano+2026 A&A](#)

**Possibly solved by 2030(!). What's next?**

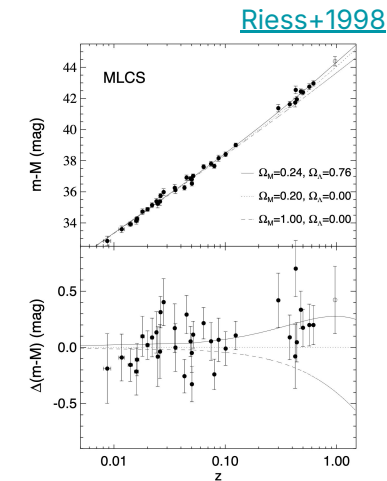
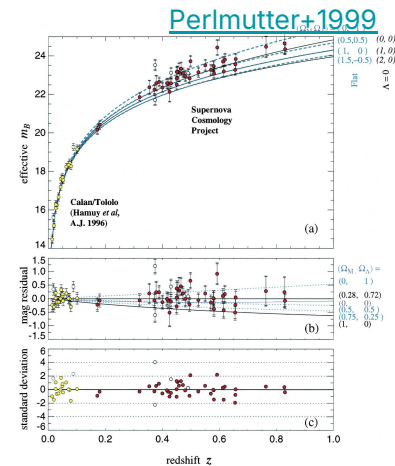


# A Route to Cosmology Independent of SNe

## OBSERVATIONAL CONTEXT

Key observational evidence for dark energy and cosmic acceleration

- Type Ia supernovae
- CMB geometry + low matter density
- Baryon Acoustic Oscillations • Large Scale Structures

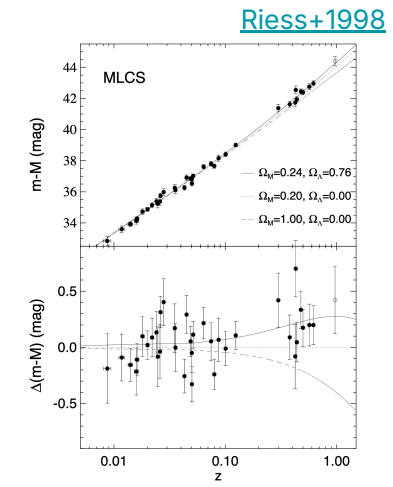
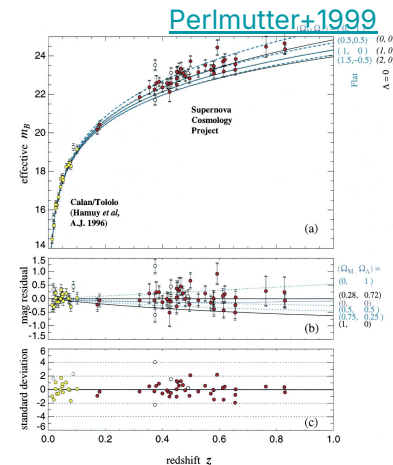
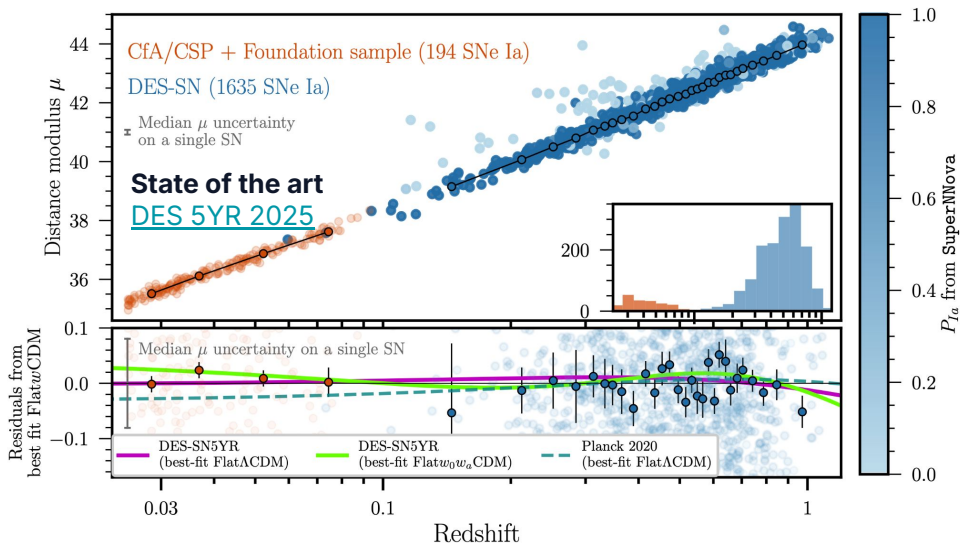


# A Route to Cosmology Independent of SNe

## OBSERVATIONAL CONTEXT

Key observational evidence for dark energy and cosmic acceleration

- Type Ia supernovae
- CMB geometry + low matter density
- Baryon Acoustic Oscillations • Large Scale Structures



# A Route to Cosmology Independent of SNe

## OBSERVATIONAL CONTEXT

Key observational evidence for dark energy and cosmic acceleration

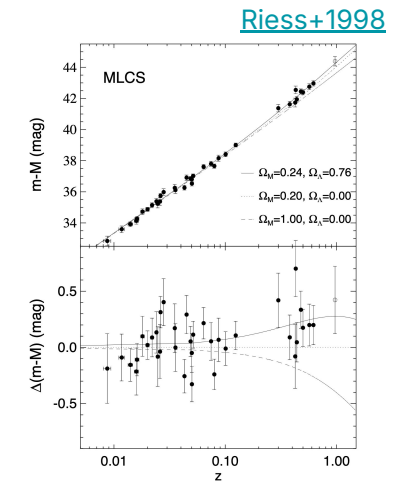
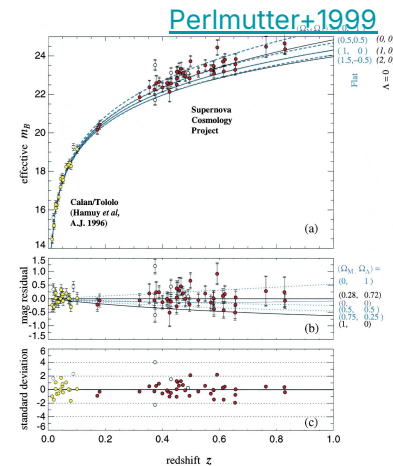
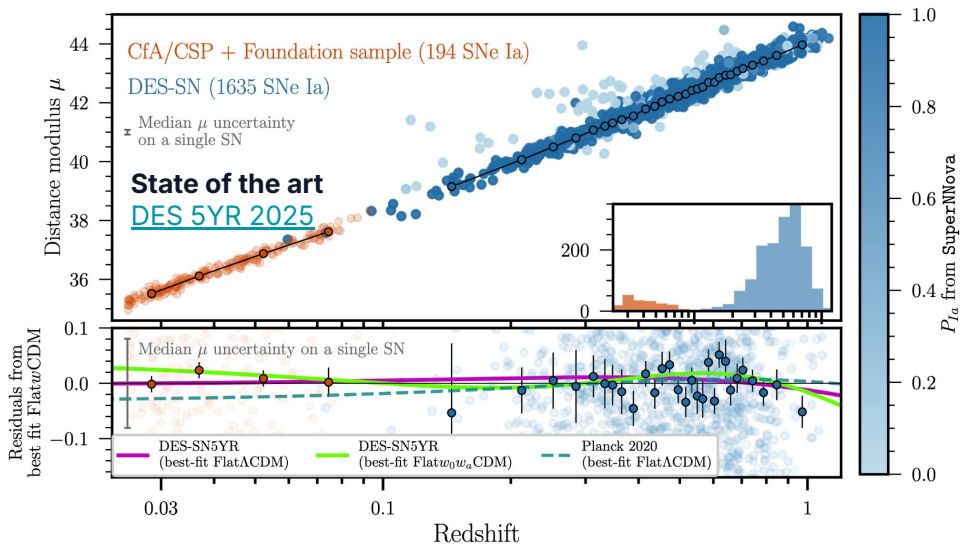
- Type Ia supernovae
- CMB geometry + low matter density
- Baryon Acoustic Oscillations • Large Scale Structures

## AN ALTERNATIVE PATH

## SBF + AO

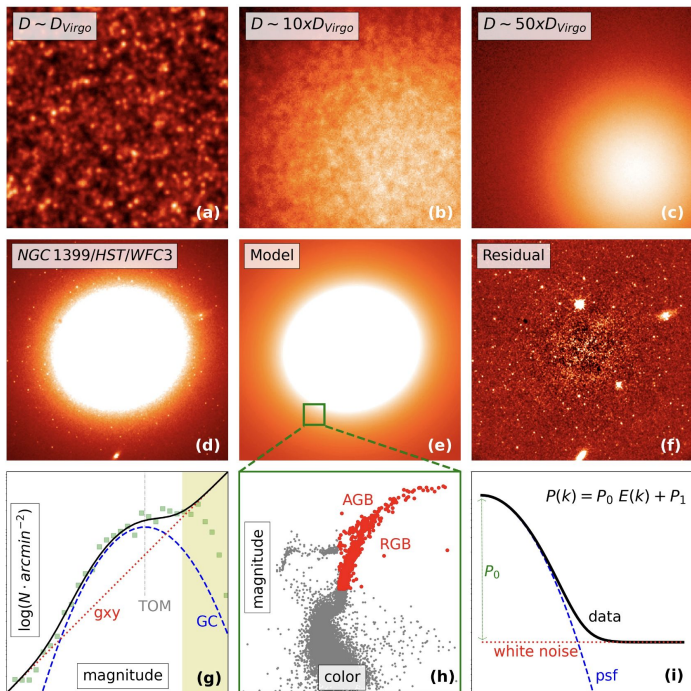
Surface Brightness  
Fluctuations +  
Adaptive Optics

An independent path to  
cosmological parameters  
(~) direct as SNe Ia



# SBF Distances

## SBF 101



MC & Blakeslee (2023)

## KEY CHARACTERISTICS

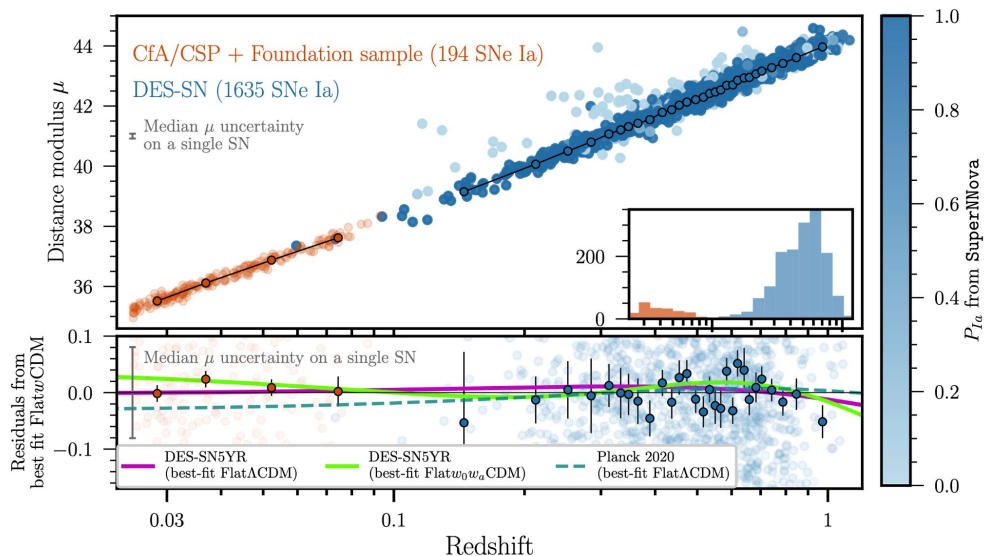
Distances ~5% precision on single targets

- Not a serendipitous event (unlike SNe Ia)
- No need for long observing campaigns (e.g. Cepheids)
- Current reach: ~300 Mpc with JWST

## ACCESSIBILITY CONDITIONS

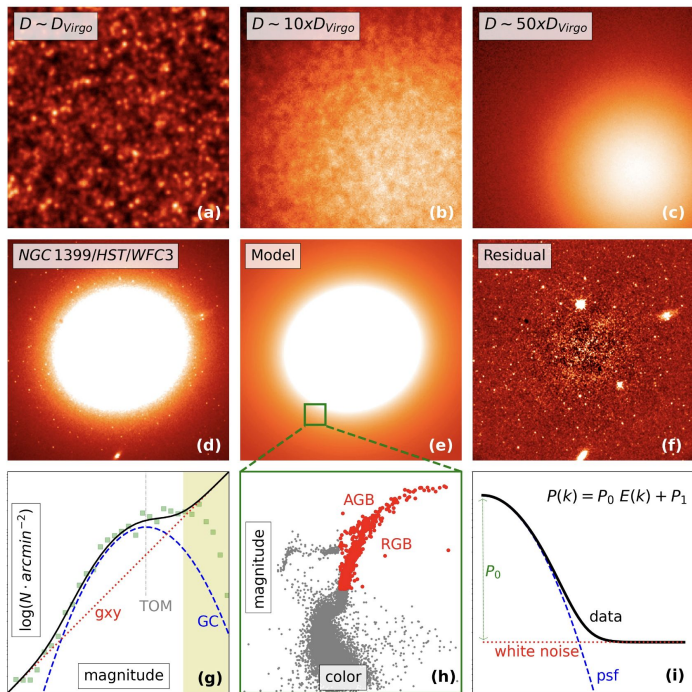
Large distances accessible with:

- High spatial resolution (~better fluctuation contrast and lower contamination)
- Deep imaging data (to model and subtract contaminants)



# SBF Distances

## SBF 101



MC & Blakeslee (2023)

## KEY CHARACTERISTICS

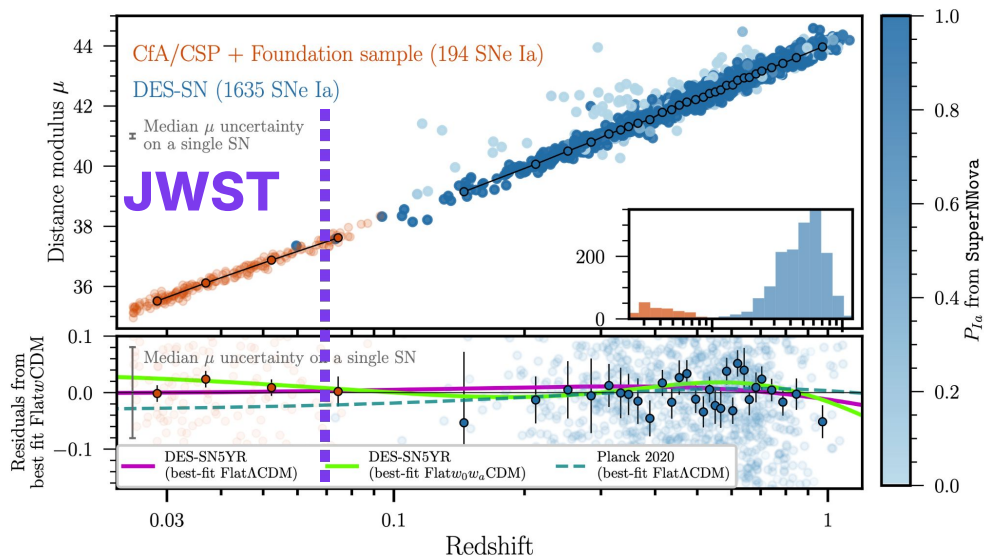
Distances ~5% precision on single targets

- Not a serendipitous event (unlike SNe Ia)
- No need for long observing campaigns (e.g. Cepheids)
- Current reach: ~300 Mpc with JWST

## ACCESSIBILITY CONDITIONS

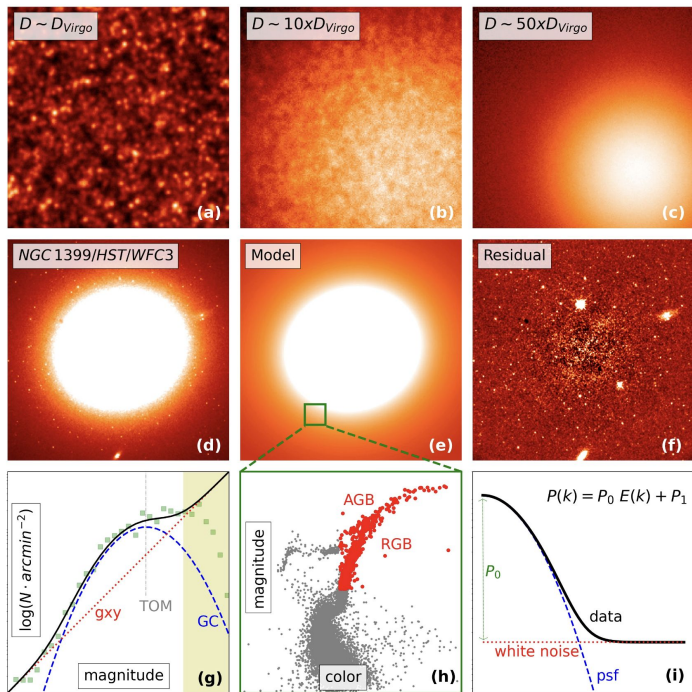
Large distances accessible with:

- High spatial resolution (~better fluctuation contrast and lower contamination)
- Deep imaging data (to model and subtract contaminants)



# SBF Distances

## SBF 101



MC & Blakeslee (2023)

## KEY CHARACTERISTICS

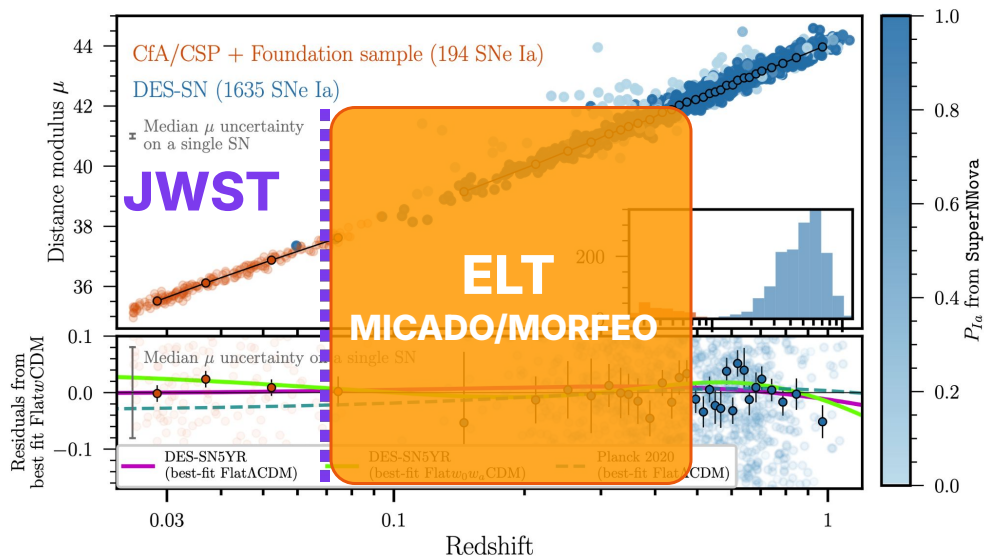
Distances ~5% precision on single targets

- Not a serendipitous event (unlike SNe Ia)
- No need for long observing campaigns (e.g. Cepheids)
- Current reach: ~300 Mpc with JWST

## ACCESSIBILITY CONDITIONS

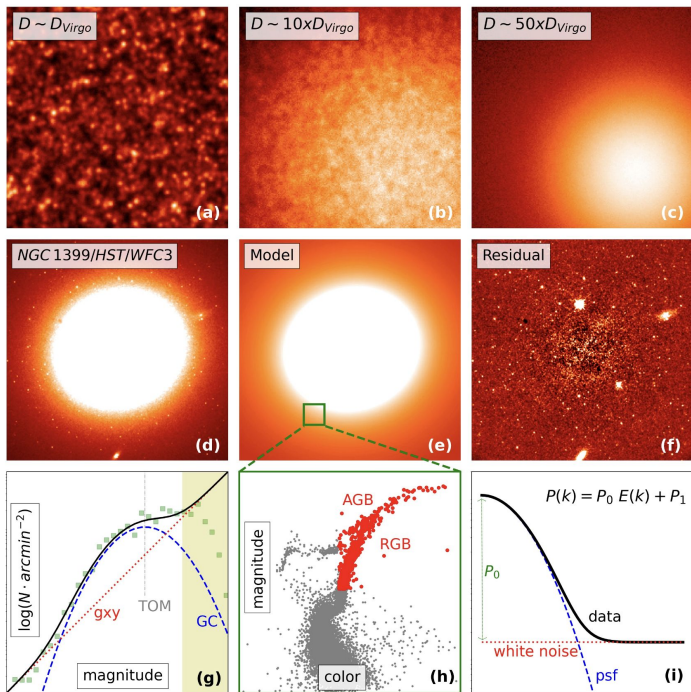
Large distances accessible with:

- High spatial resolution (~better fluctuation contrast and lower contamination)
- Deep imaging data (to model and subtract contaminants)



# SBF Distances

## SBF 101



MC & Blakeslee (2023)

## KEY CHARACTERISTICS

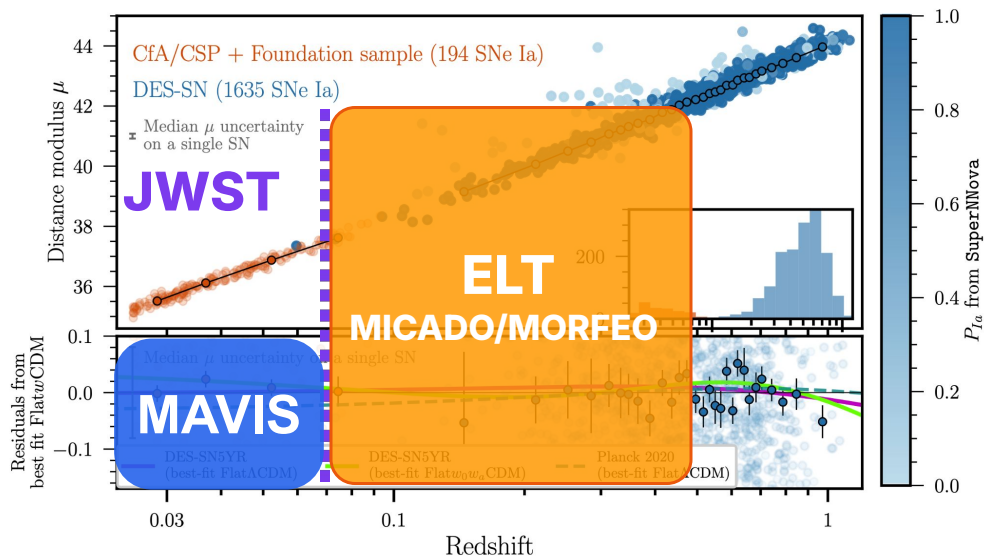
Distances ~5% precision on single targets

- Not a serendipitous event (unlike SNe Ia)
- No need for long observing campaigns (e.g. Cepheids)
- Current reach: ~300 Mpc with JWST

## ACCESSIBILITY CONDITIONS

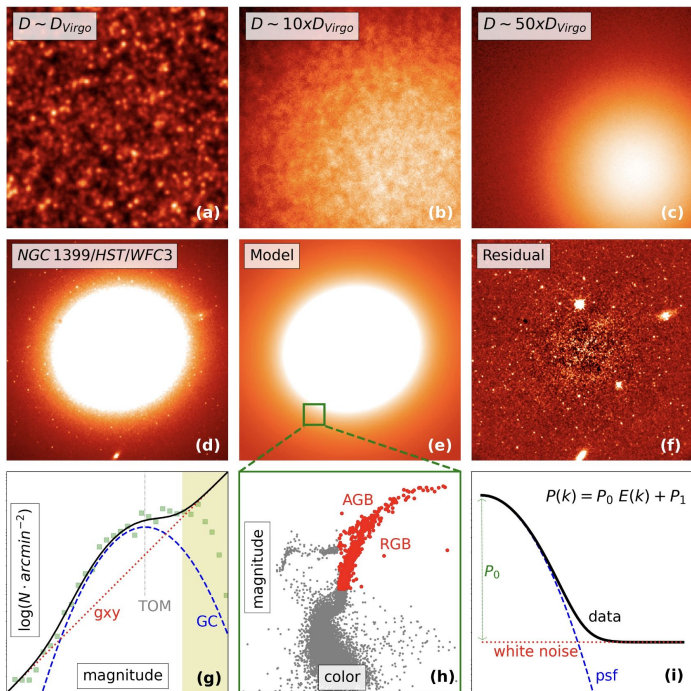
Large distances accessible with:

- High spatial resolution (~better fluctuation contrast and lower contamination)
- Deep imaging data (to model and subtract contaminants)



# SBF Distances

## SBF 101



MC & Blakeslee (2023)

## KEY CHARACTERISTICS

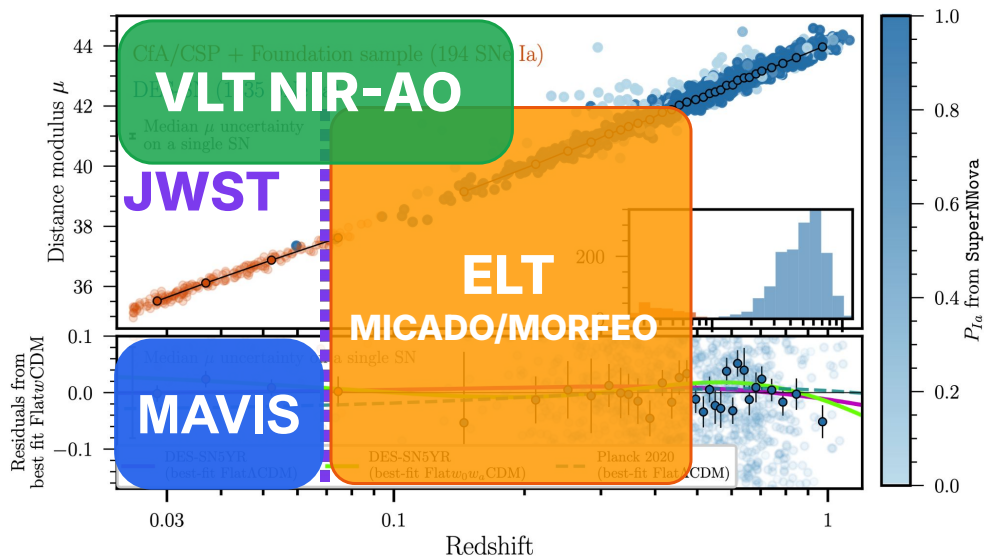
Distances ~5% precision on single targets

- Not a serendipitous event (unlike SNe Ia)
- No need for long observing campaigns (e.g. Cepheids)
- Current reach: ~300 Mpc with JWST

## ACCESSIBILITY CONDITIONS

Large distances accessible with:

- High spatial resolution (~better fluctuation contrast and lower contamination)
- Deep imaging data (to model and subtract contaminants)



# Advocating for Near-IR AO-Assisted Imaging

## Cosmology Requires Statistics

- **ELT**  $\Rightarrow$  Detail & Spatial resolution
- **VLT**  $\Rightarrow$  Larger statistics

## Surface Brightness Fluctuations

**ELT / MICADO / MORFEO:**

Reach the  $\sim$ SNe Ia distance regime

**VLT / NIR-AO:** Enables methodological improvement, calibration & statistical samples out to  $z \sim 0.2$  (?)

## KEY CHARACTERISTICS

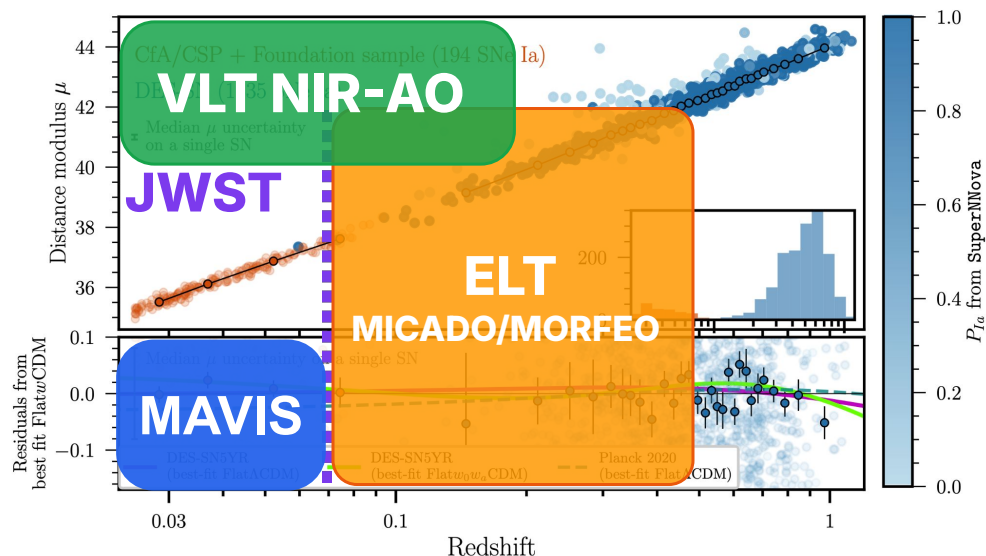
Distances  $\sim 5\%$  precision on single targets

- Not a serendipitous event (unlike SNe Ia)
- No need for long observing campaigns (e.g. Cepheids)
- Current reach:  $\sim 300$  Mpc with JWST

## ACCESSIBILITY CONDITIONS

Large distances accessible with:

- High spatial resolution ( $\sim$ better fluctuation contrast and lower contamination)
- Deep imaging data (to model and subtract contaminants)



# Advocating for Near-IR AO-Assisted Imaging

## Cosmology Requires Statistics

- **ELT**  $\Rightarrow$  Detail & Spatial resolution
- **VLT**  $\Rightarrow$  Larger statistics

## Why another NIR-AO?

- $\rightarrow$  NIR: higher res. & less contamination
- $\rightarrow$  Brighter SBF
- $\rightarrow$  Potentially farther than JWST in a cosmologically relevant regime
- $\rightarrow$  Improvement on method (SBF+AO) calibration
- $\rightarrow$  statistical samples out to  $z \sim 0.2$

## KEY CHARACTERISTICS

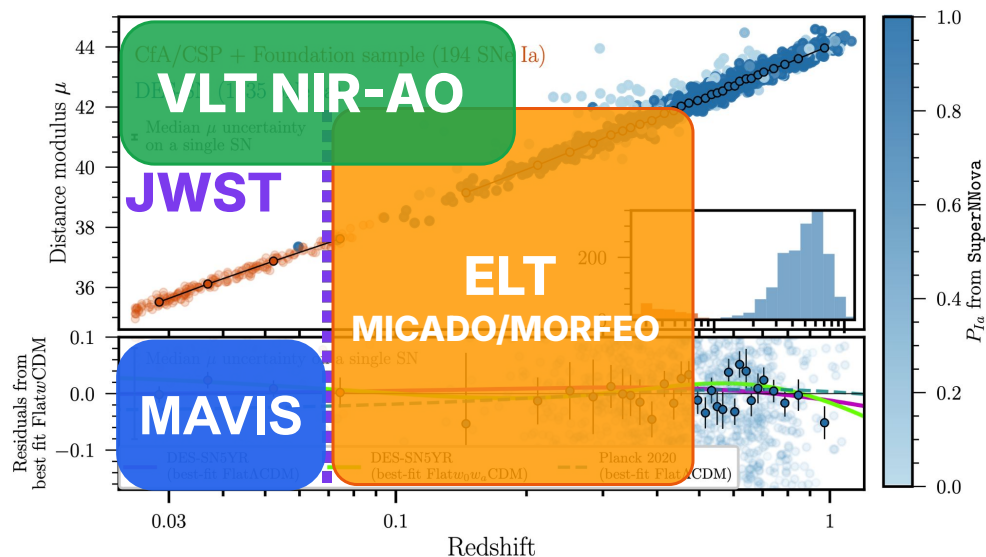
Distances  $\sim 5\%$  precision on single targets

- Not a serendipitous event (unlike SNe Ia)
- No need for long observing campaigns (e.g. Cepheids)
- Current reach:  $\sim 300$  Mpc with JWST

## ACCESSIBILITY CONDITIONS

Large distances accessible with:

- High spatial resolution ( $\sim$ better fluctuation contrast and lower contamination)
- Deep imaging data (to model and subtract contaminants)



# Advocating for Near-IR AO-Assisted Imaging

## Cosmology Requires Statistics

- **ELT**  $\Rightarrow$  Detail & Spatial resolution
- **VLT**  $\Rightarrow$  Larger statistics

## Why another NIR-AO?

- $\rightarrow$  NIR: higher res. & less contamination
- $\rightarrow$  Brighter SBF
- $\rightarrow$  Potentially farther than JWST in a cosmologically relevant regime
- $\rightarrow$  Improvement on method (SBF+AO) calibration
- $\rightarrow$  statistical samples out to  $z \sim 0.2$

... and there is much more than SBF  
**Thank you!**

## KEY CHARACTERISTICS

Distances  $\sim 5\%$  precision on single targets

- Not a serendipitous event (unlike SNe Ia)
- No need for long observing campaigns (e.g. Cepheids)
- Current reach:  $\sim 300$  Mpc with JWST

## ACCESSIBILITY CONDITIONS

Large distances accessible with:

- High spatial resolution ( $\sim$ better fluctuation contrast and lower contamination)
- Deep imaging data (to model and subtract contaminants)

