

In Here: Dwarf Galaxies in the OutThere Survey

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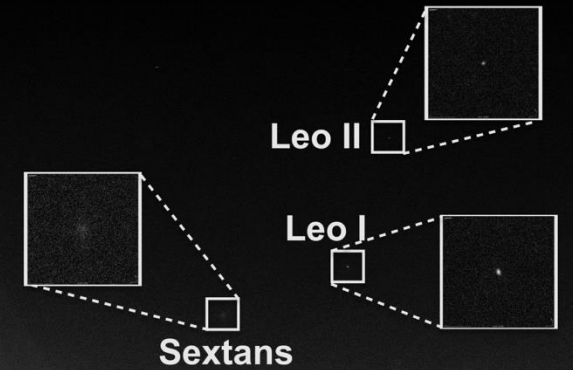
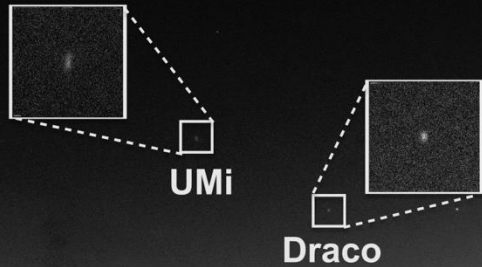
With Ivelina Momcheva, Raphael Erik Hviding,

Jiaxuan Li, Erik Tollerud, Yang Cheng,

Morgan Fouesneau, Aarya Patil

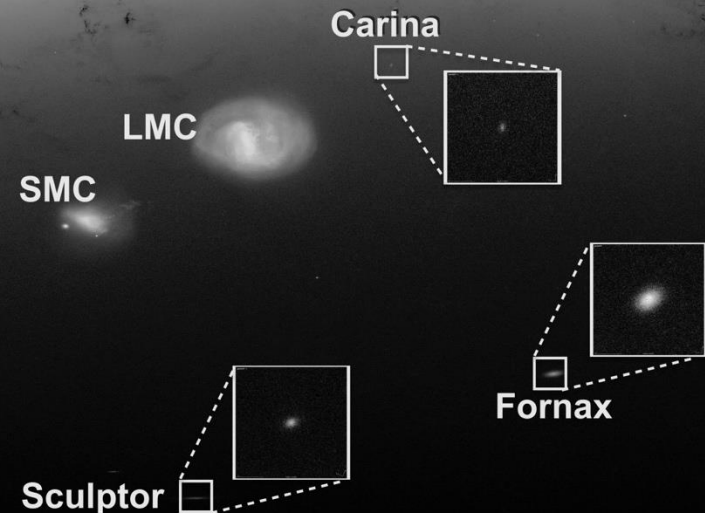
MPIA Galaxy Coffee
Sep 4th, 2025

Dwarf Galaxies



Small galaxies contain just few billion stars with $M_* < 10^9 M_\odot$

- Tracers of early galaxy formation and evolution
- Key Lab to test different dark matter models



OutThere JWST/NIRISS Pure-Parallel Survey



PI: Karl Glazebrook

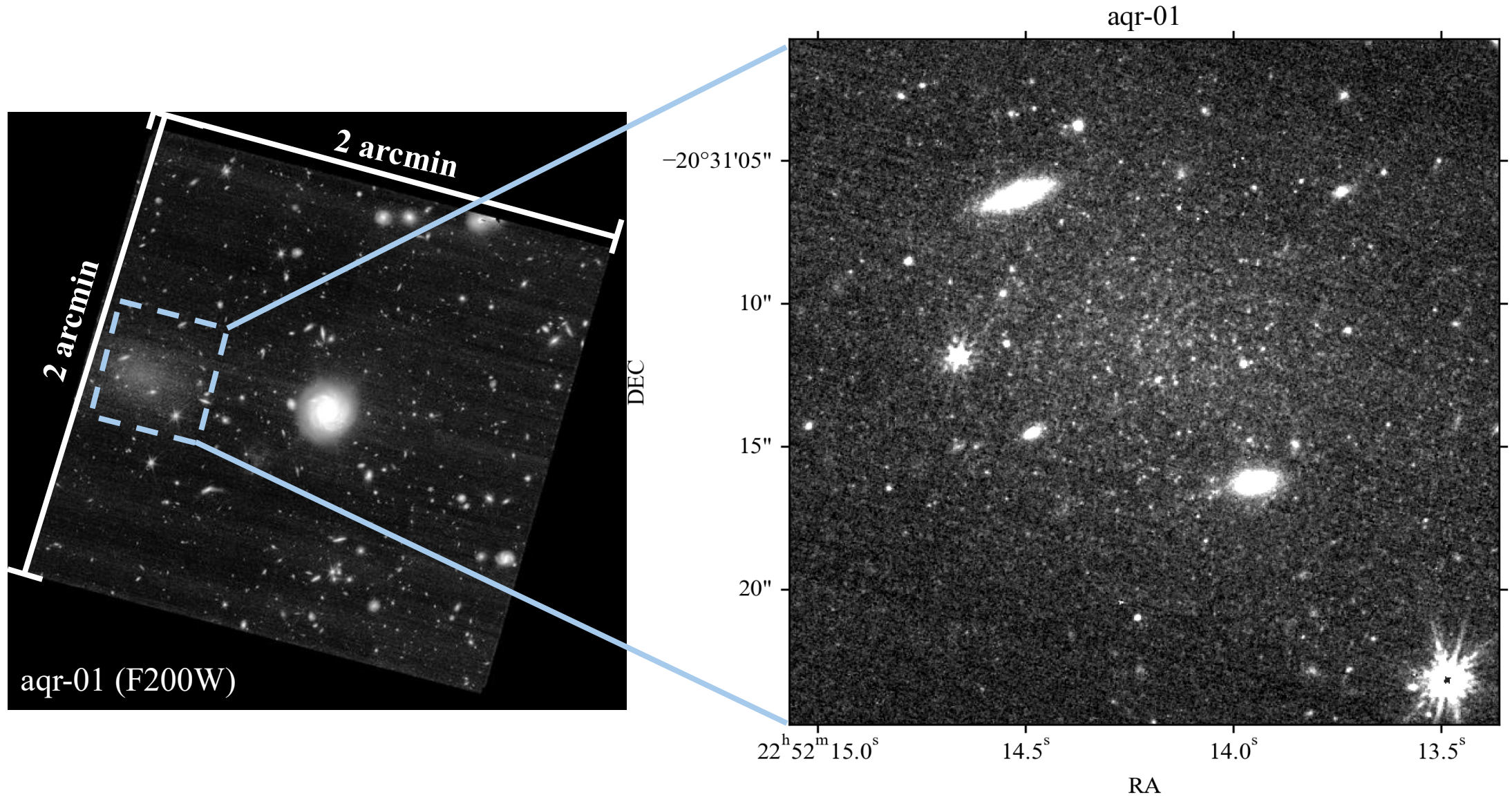
JWST/NIRISS 1000 arcmin² pure parallel spectroscopic survey (Table 1)

| | |
|---|--|
| 20,000 $z>1$ continuum spectra $K<24$ 1.4–2.2μm | 3000 massive galaxies at $z>1.5$ |
| 60,000 spectroscopic redshifts | 250 massive quiescent galaxies at $z>3$ |
| 20 Coma clusters ancestors at $z>2$ identified in 3D | 2000 spatially resolved $z\sim 2$ emission line images in multiple lines |
| 2000 reionization analog galaxies at $z\sim 3$ | $z>10$ bright sources. Unknown populations. |

Unexpected Discoveries

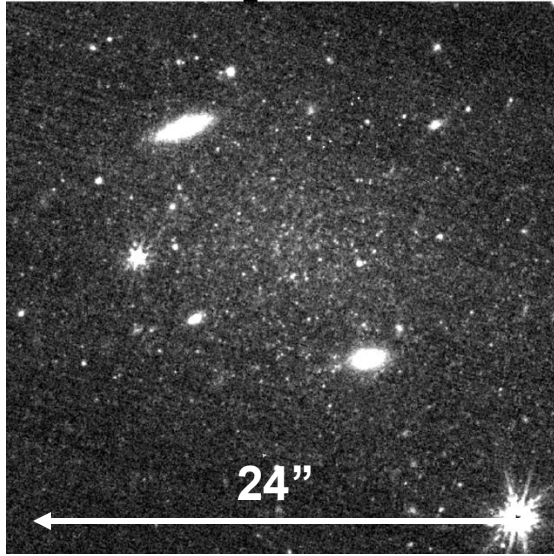
Nearby Dwarf Galaxies

OutThere JWST/NIRISS Pure-Parallel Survey

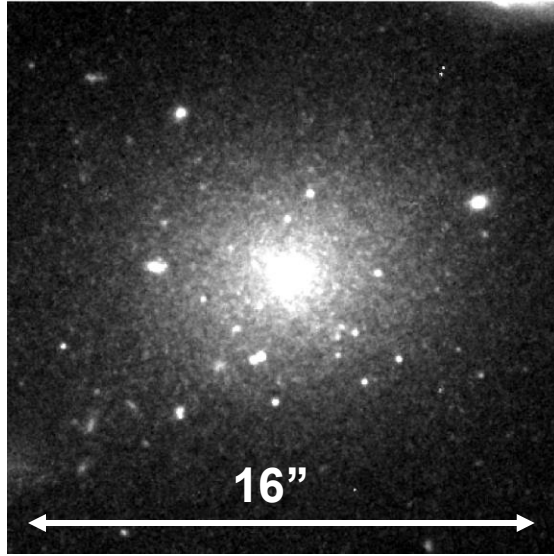


Dwarf Galaxies in OutThere Survey

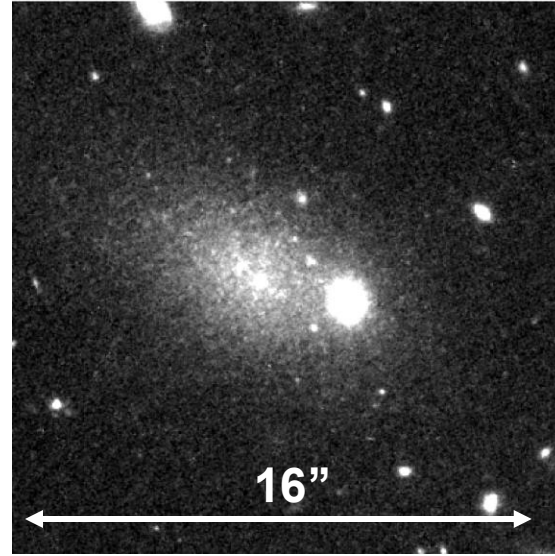
agr-01



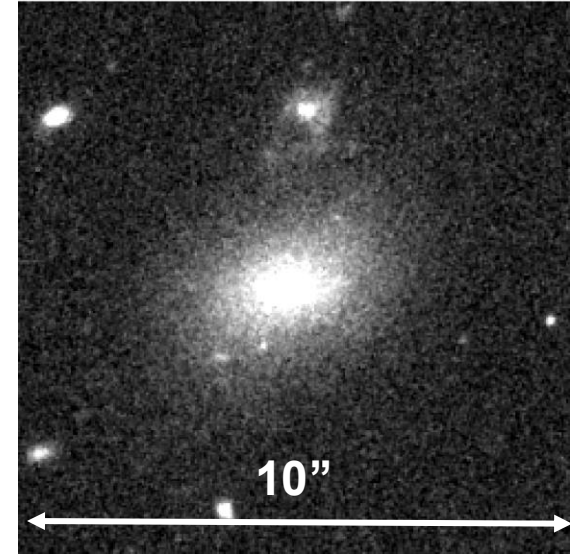
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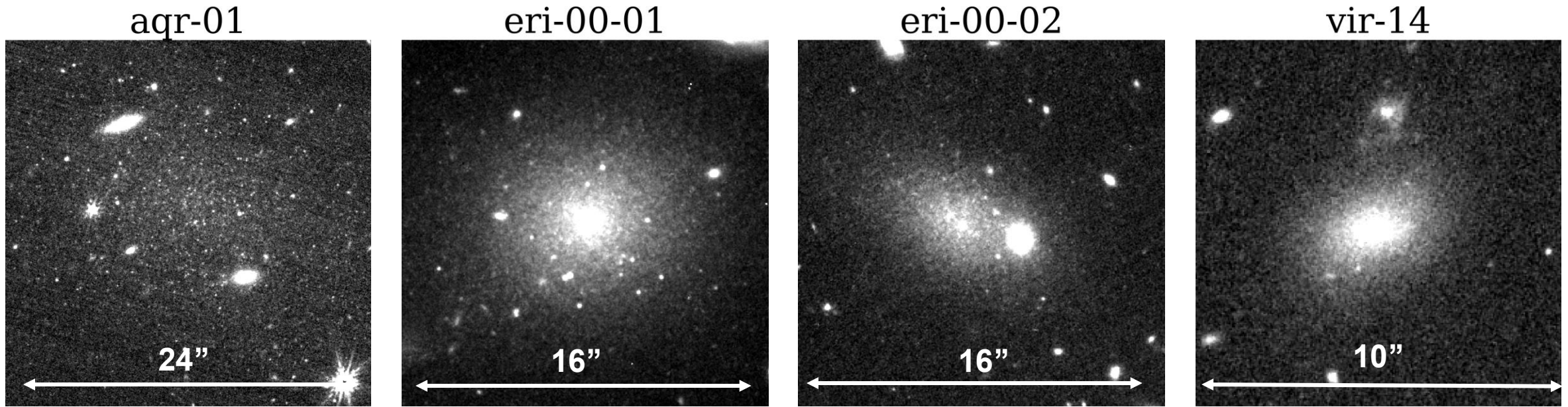
eri-00-02



vir-14



Dwarf Galaxies in OutThere Survey

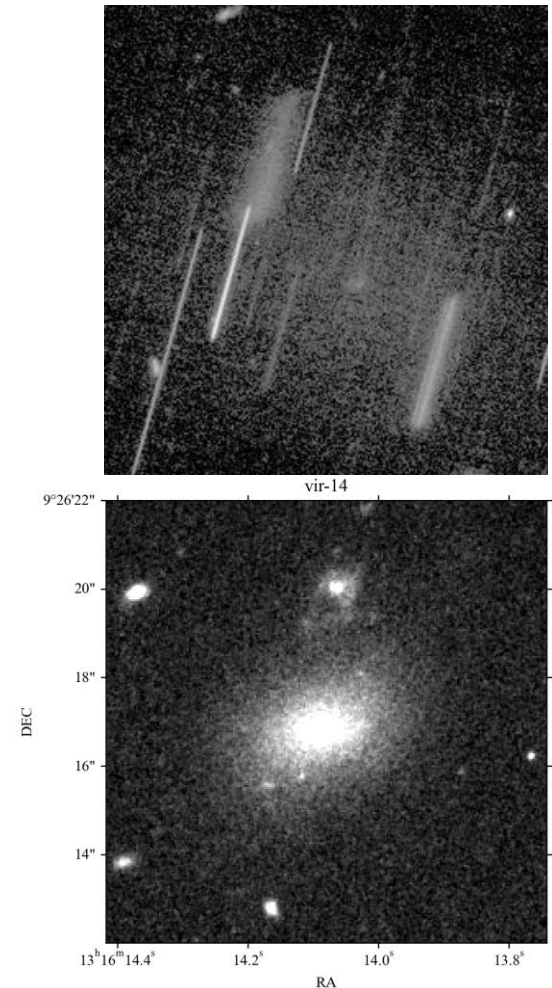


Goal of project

- **Determine the distances of the four discovered dwarf galaxies.**
- **Determine their masses and place them in a cosmological context.**

Distance Measurement Methods

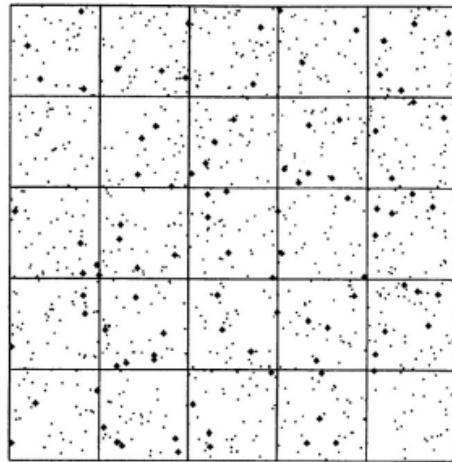
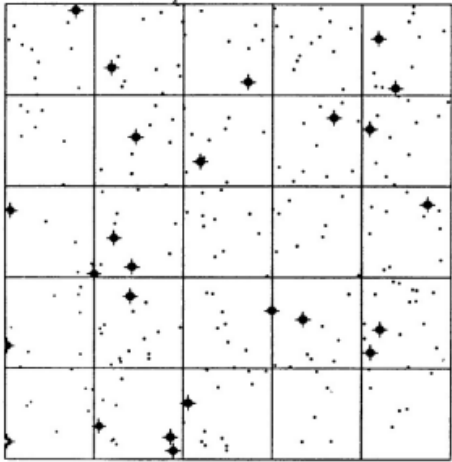
- ✗ Spectrum: Hard to determine wavelength for extended galaxies
- ✗ Resolved Stars: TRGB, variable stars
- ✗ CMD: only have F200W, without color
- ✓ Surface Brightness Fluctuation (SBF)



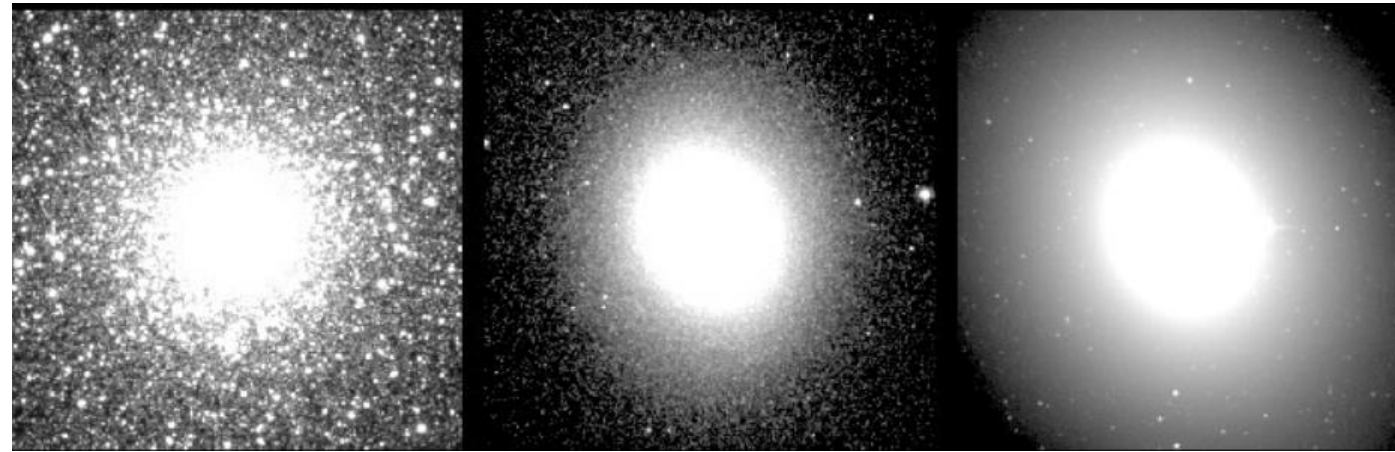
Surface Brightness Fluctuation (SBF)

Tonry & Schneider (1988)

Distance range: 10-100Mpc



Jacoby et al., 1992, PASP 104, 599

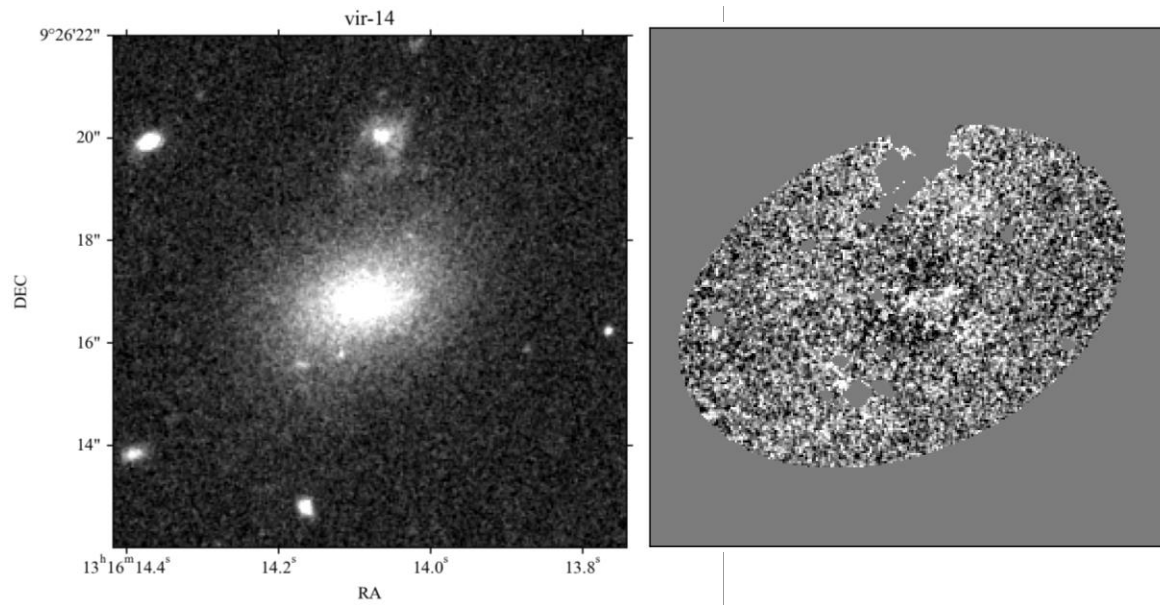


close

$\text{SBF} \propto 1/d^2$

far

Surface Brightness Fluctuation (SBF)



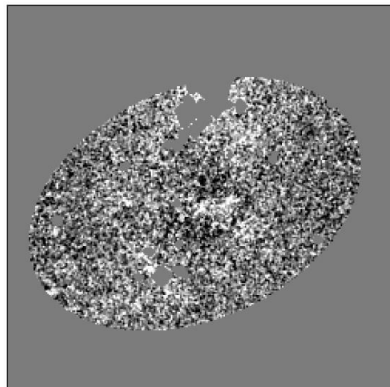
Data – non-SBF variance
(smooth galaxy profile, background, nearby objects)

Residual

Image Space
 $= \text{SBF} + \text{Noise}$

Fourier Space
 $= \text{SBF signal} \times [\text{PSF} * \text{Mask}] + \text{Noise}$

Surface Brightness Fluctuation (SBF)



Data – non-SBF variance
(smooth galaxy profile, background, nearby objects)



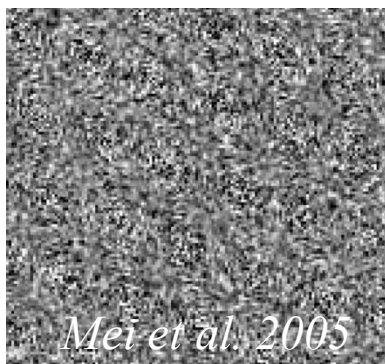
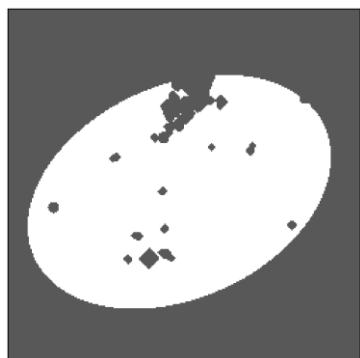
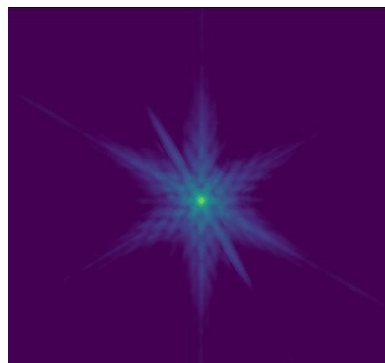
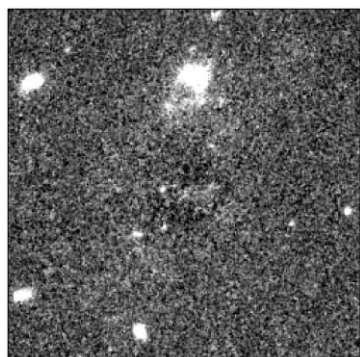
Residual

Image Space

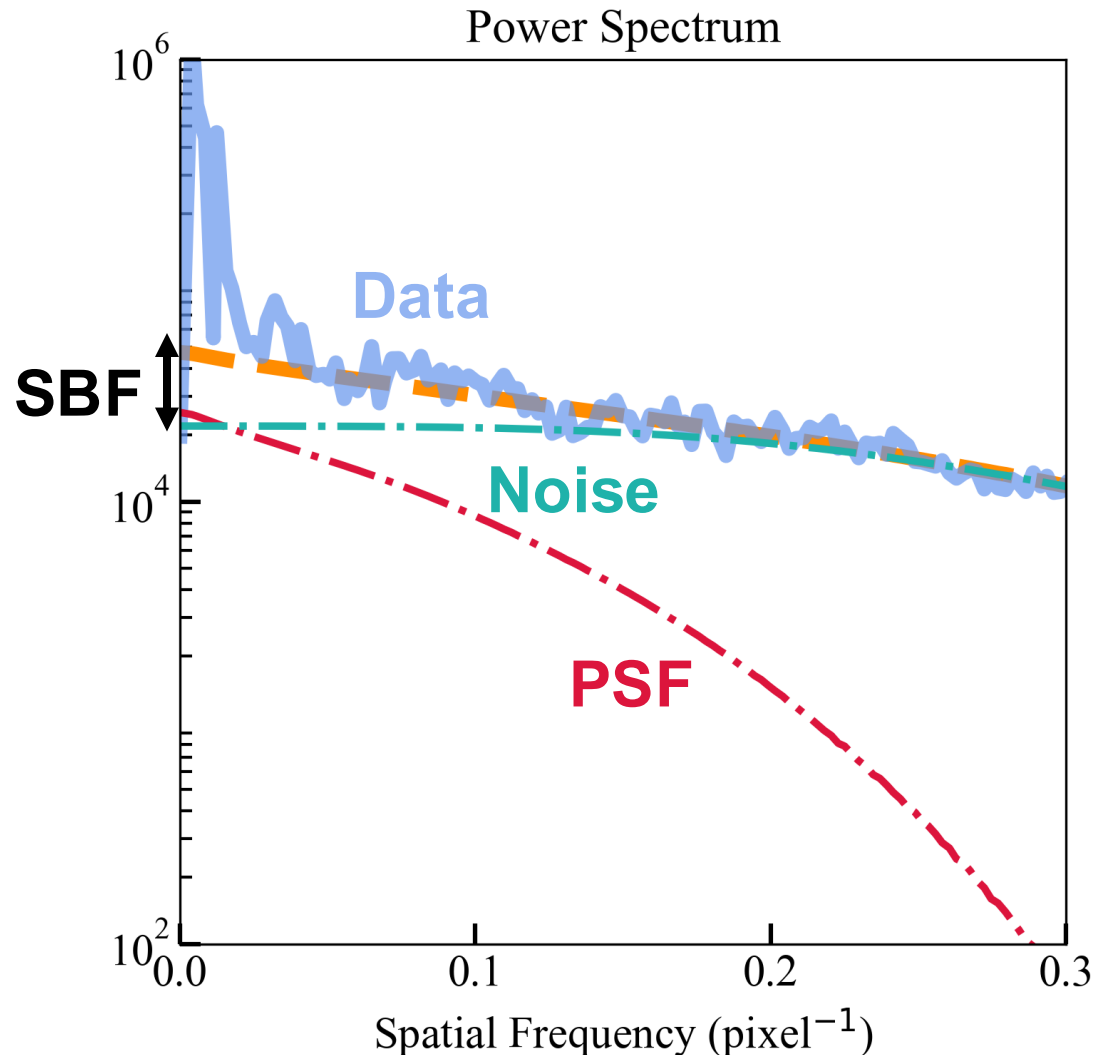
$$= \text{SBF} + \text{Noise}$$

Fourier Space

$$= \text{SBF signal} \times [\text{PSF} * \text{Mask}] + \text{Noise}$$



Surface Brightness Fluctuation (SBF)



Data – non-SBF variance
(smooth galaxy profile, background, nearby objects)

Residual

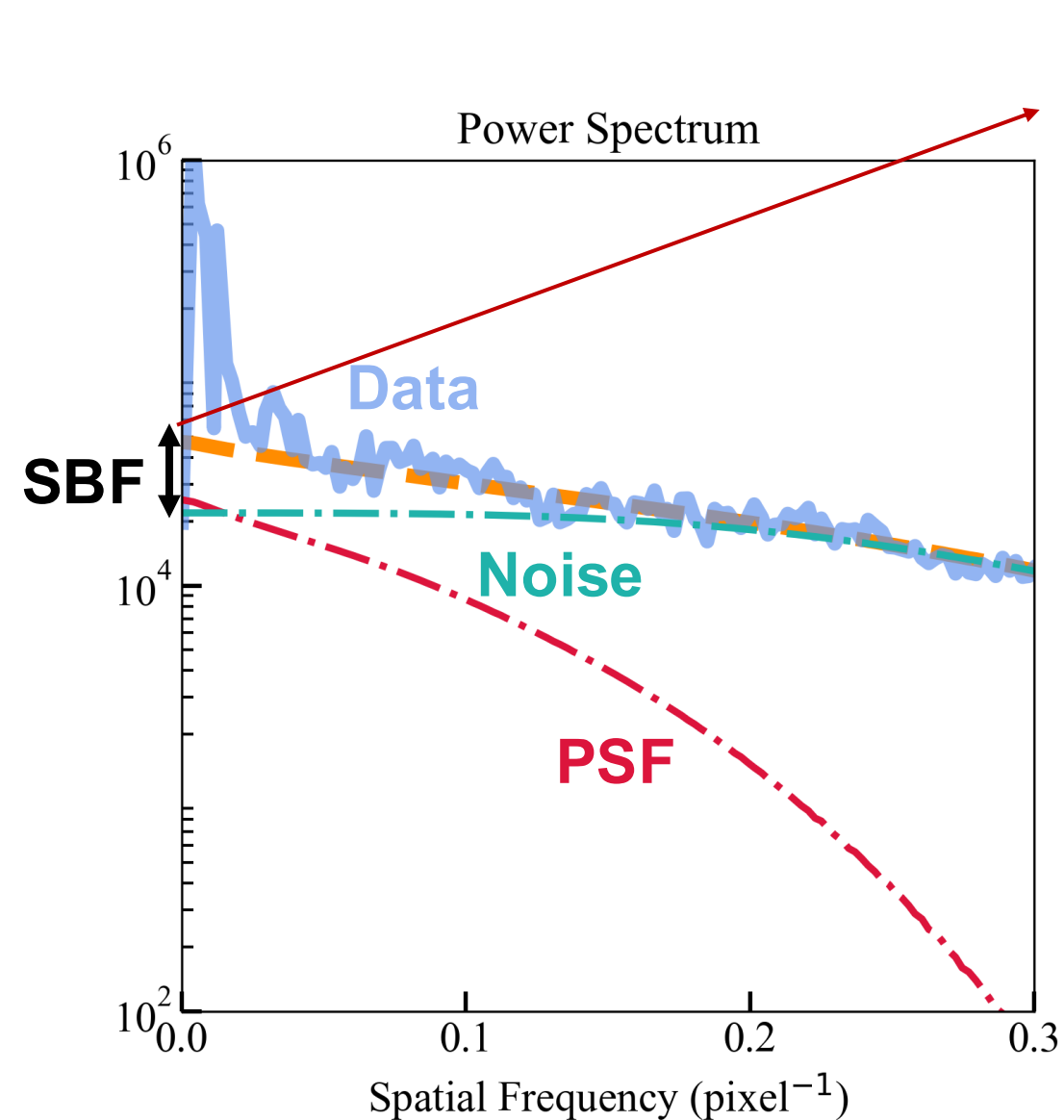
Image Space

$$= \text{SBF} + \text{Noise}$$

Fourier Space

$$= \text{SBF signal} \times [\text{PSF} * \text{Mask}] + \text{Noise}$$

Surface Brightness Fluctuation (SBF)



$$m_{\text{SBF}} - M_{\text{SBF}} = 5 \log_{10} \frac{d}{10 \text{pc}}$$

?

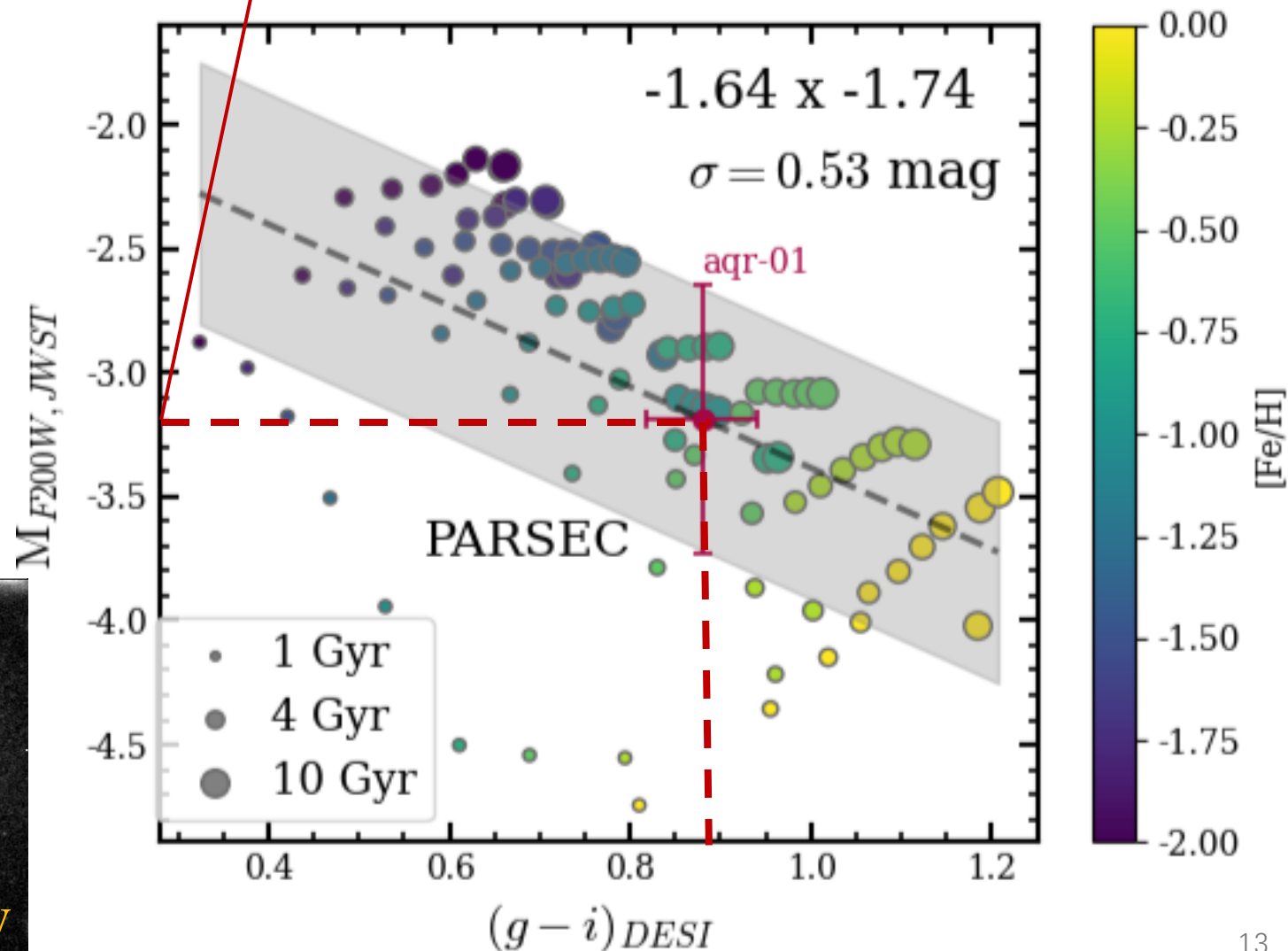
Calibration

Calibration

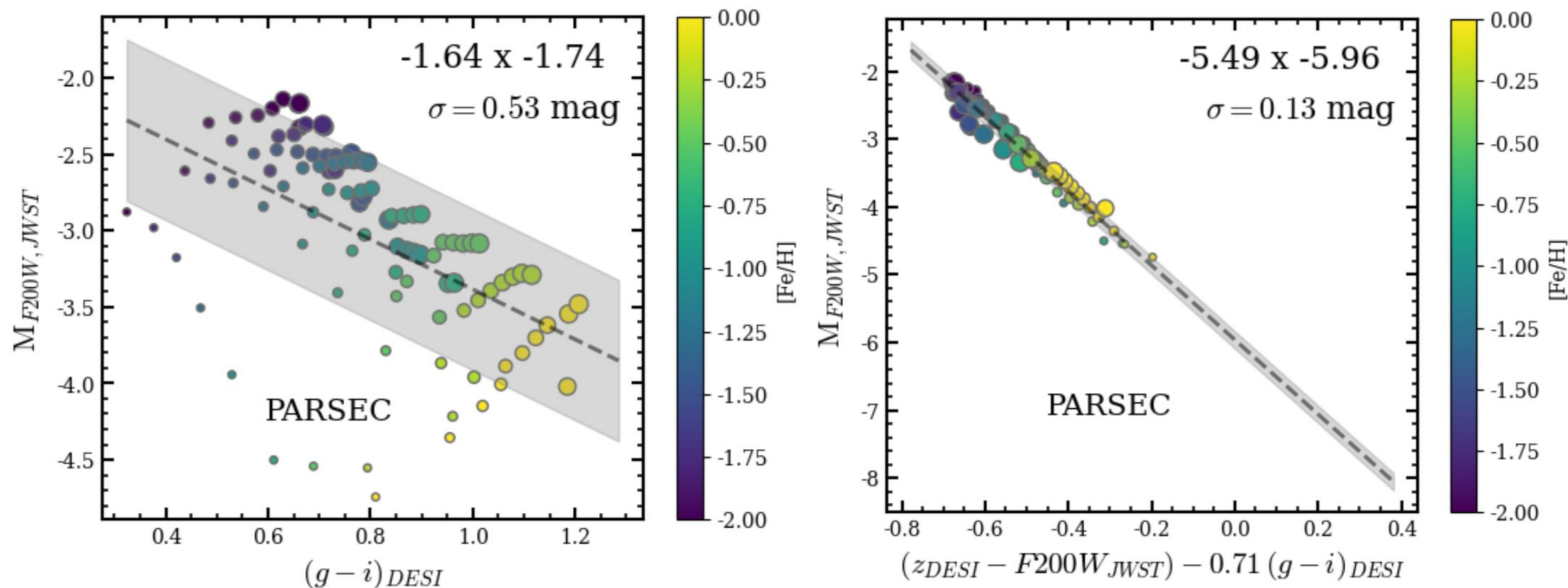
- M_{SBF} varies with metallicities & ages
- No calibration in JWST F200W.
- Stellar population synthesis Model



$$m_{\text{SBF}} - \boxed{M_{\text{SBF}}} = 5 \log_{10} \frac{d}{10 \text{ pc}}$$

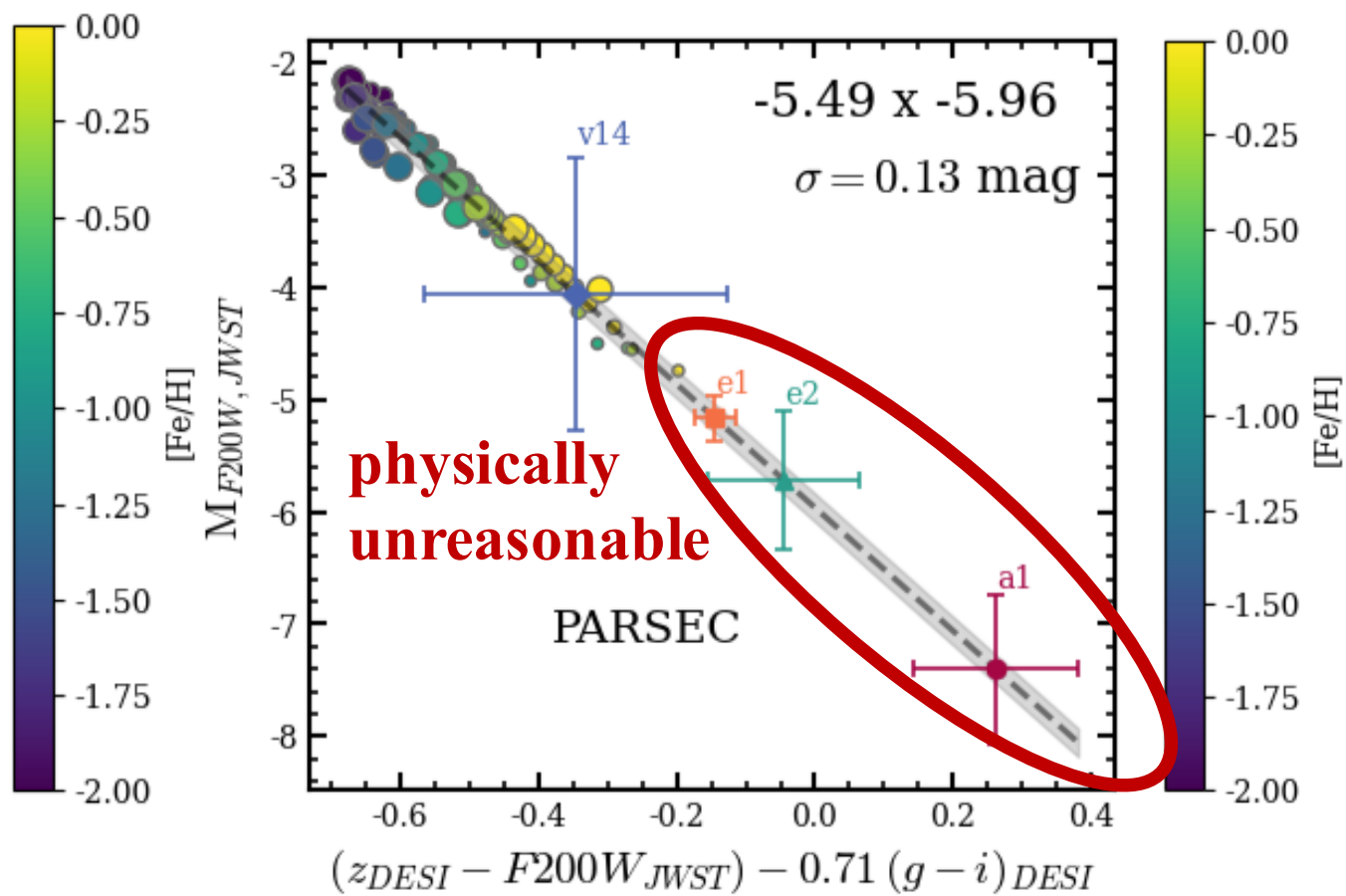
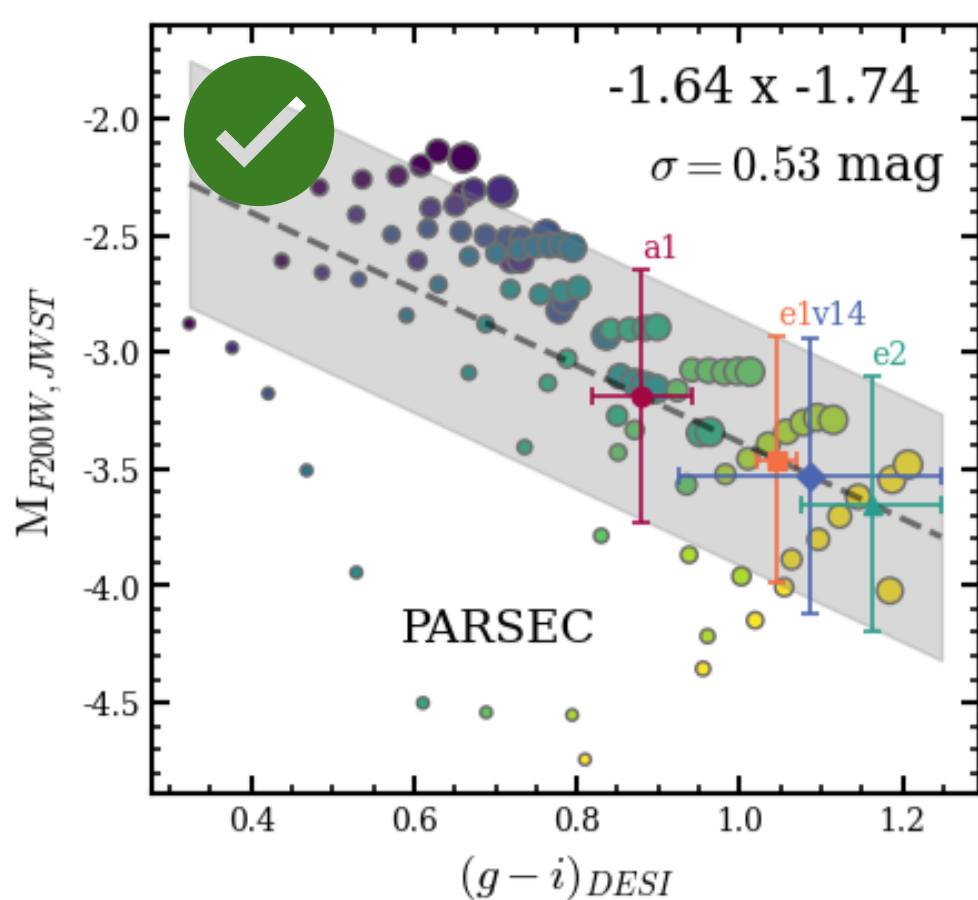


Calibration



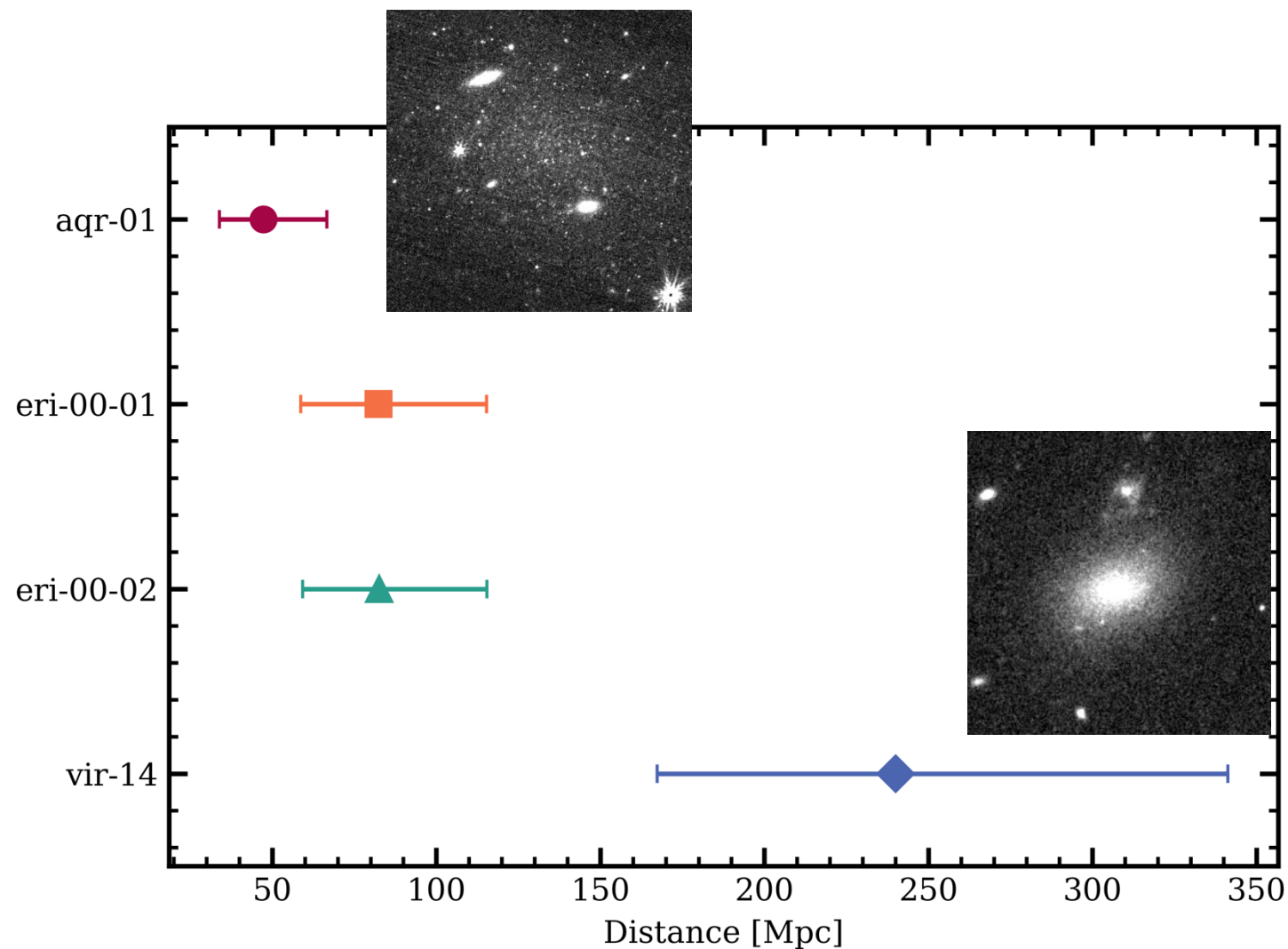
Calibration

ZP / Photometry issue...



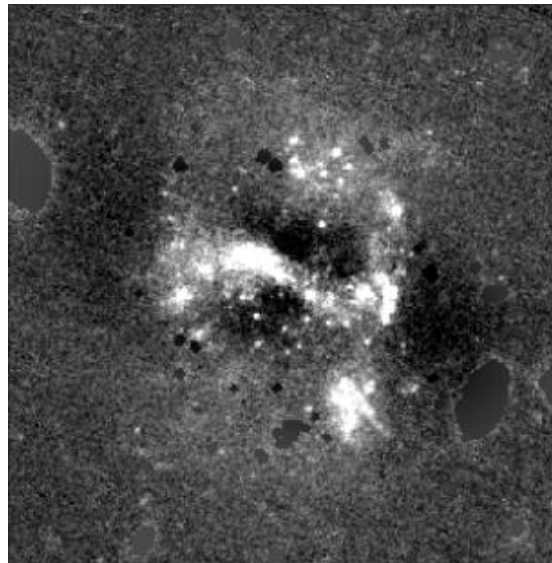
Distance

| Galaxy | $(g - i)_{DES I}$ |
|-----------|----------------------------|
| aqr-01 | $47.22^{+13.19}_{-10.29}$ |
| eri-00-01 | $82.37^{+22.95}_{-17.35}$ |
| eri-00-02 | $82.72^{+23.89}_{-18.33}$ |
| vir-14 | $239.22^{+73.03}_{-55.20}$ |



Future Work

- ❑ Check Distance results
- ❑ Determine masses and place them in a cosmological context
- ❑ Resolved Stellar Populations & Extra Distance constraint
- ❑ Spectroscopy of Star-Forming region



Summary

- ✓ Identified 4 dwarf galaxies in the OutThere Survey
- ✓ Measured distances using SBF for all dwarf galaxies
- ✓ Distances range from 40–200 Mpc

