



In Here: Dwarf Galaxies in the OutThere Survey

Shirui Wei

National Astronomical Observatories, Chinese Academy of Sciences (NAOC)

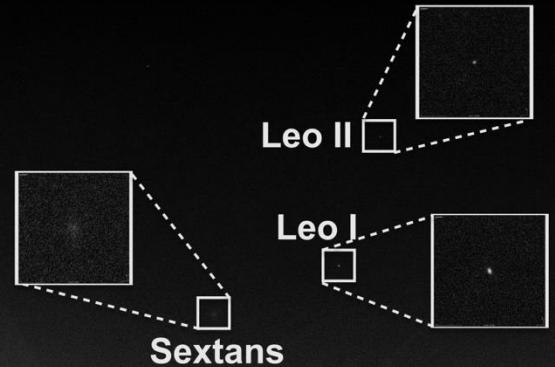
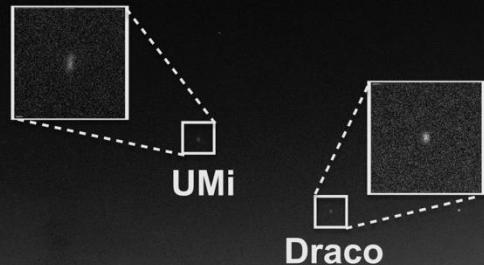
With Ivelina Momcheva, Raphael Erik Hviding,

Jiaxuan Li, Erik Tollerud, Yang Cheng,

Morgan Fouesneau, Aarya Patil

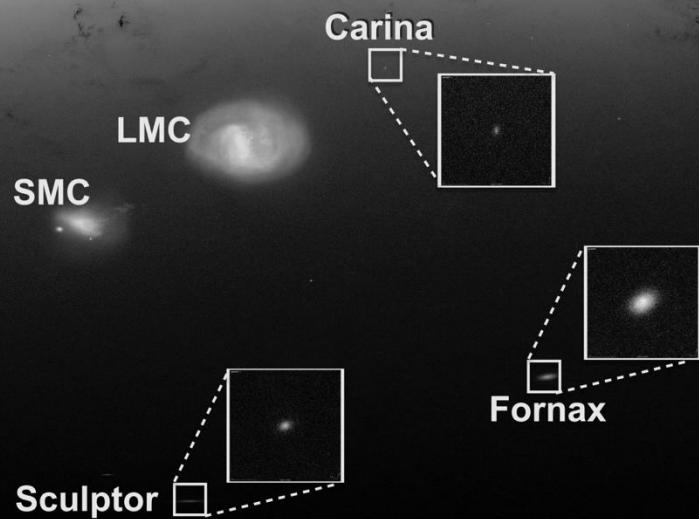
MPIA Galaxy Coffee
Sep 4th, 2025

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





PI: Karl Glazebrook

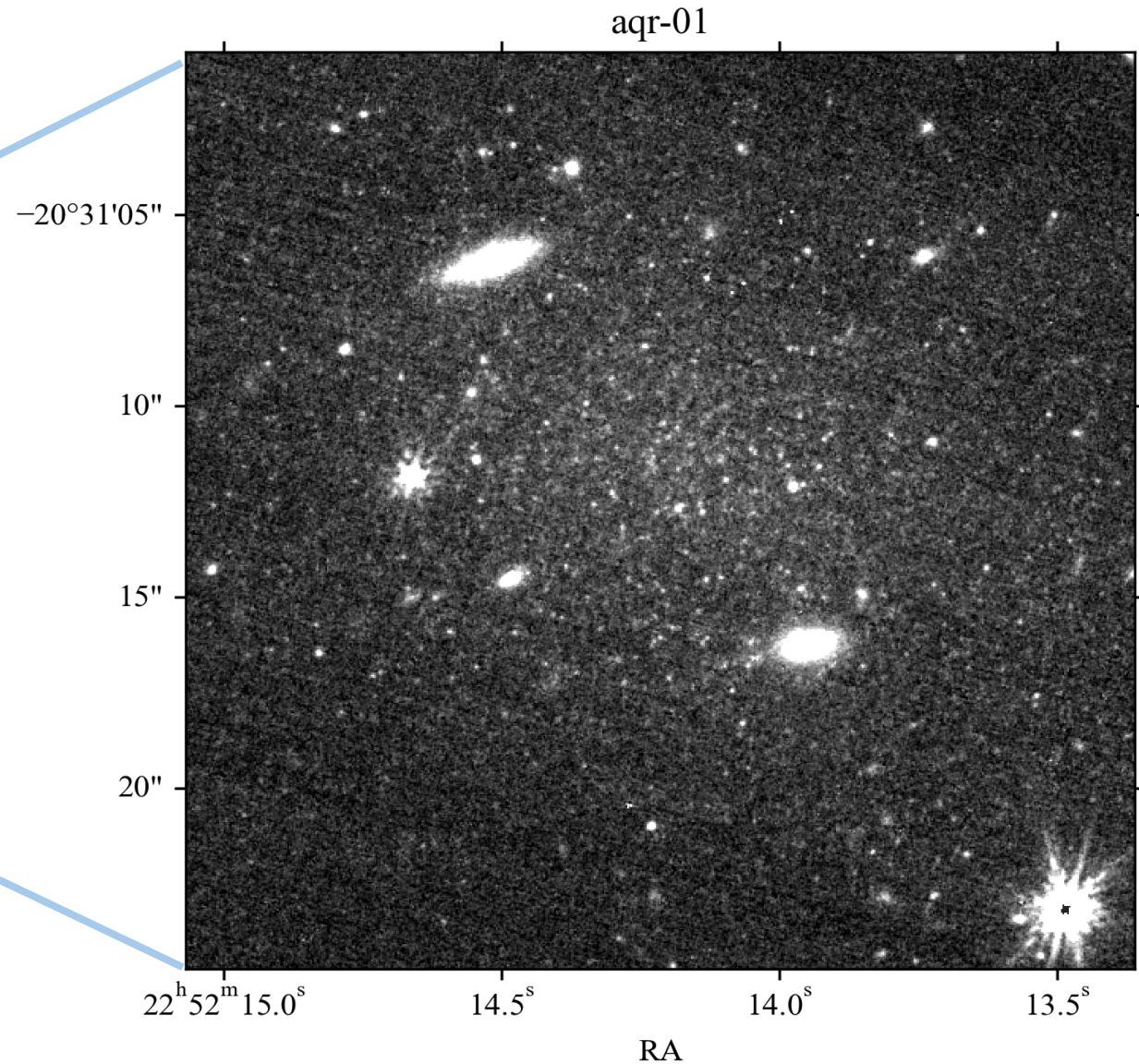
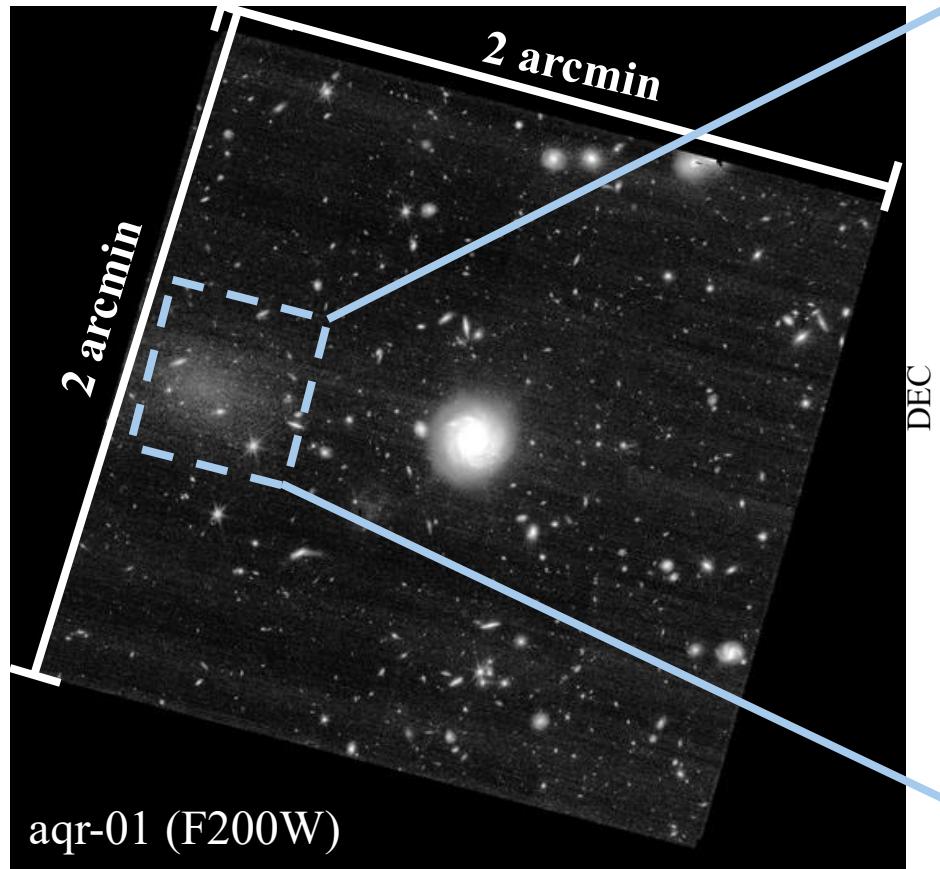
JWST/NIRISS 1000 arcmin² pure parallel spectroscopic survey (Table 1)

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.

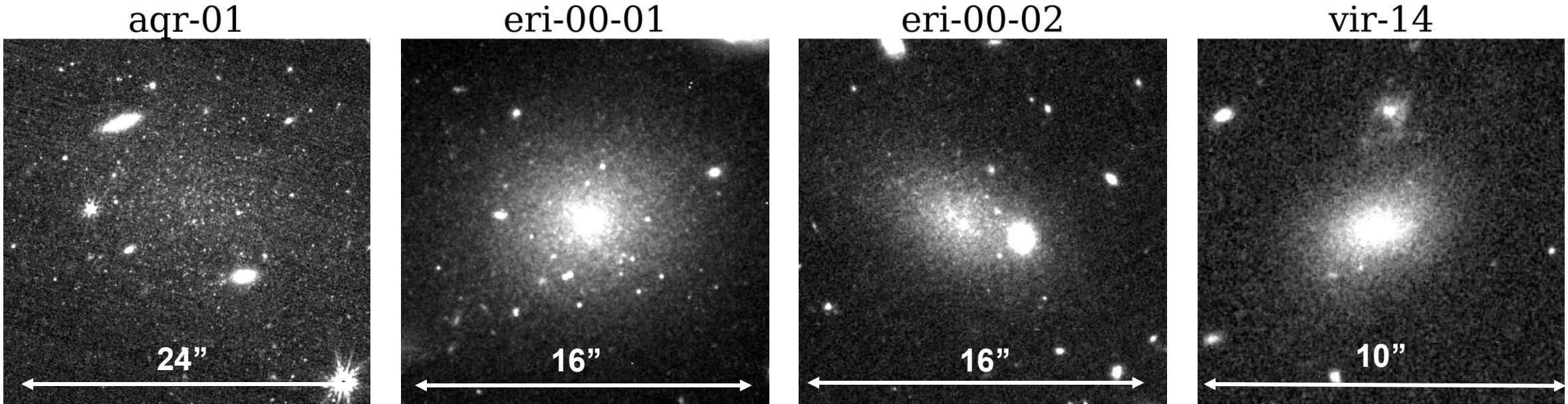
Unexpected Discoveries**Nearby Dwarf Galaxies**

OutThere

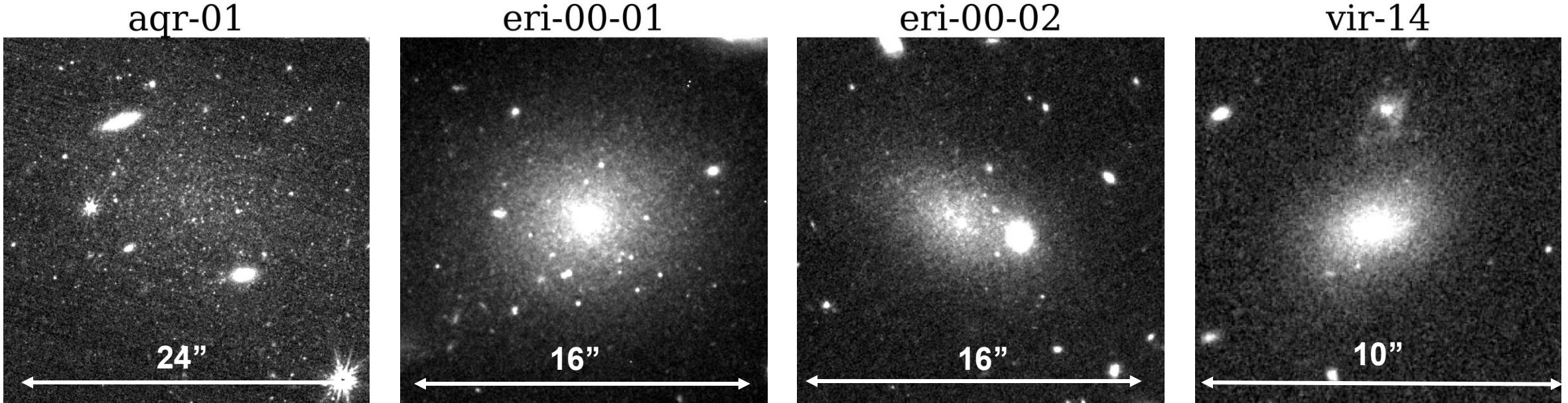
JWST/NIRISS Pure-Parallel Survey



Dwarf Galaxies in OutThere Survey



Dwarf Galaxies in OutThere Survey



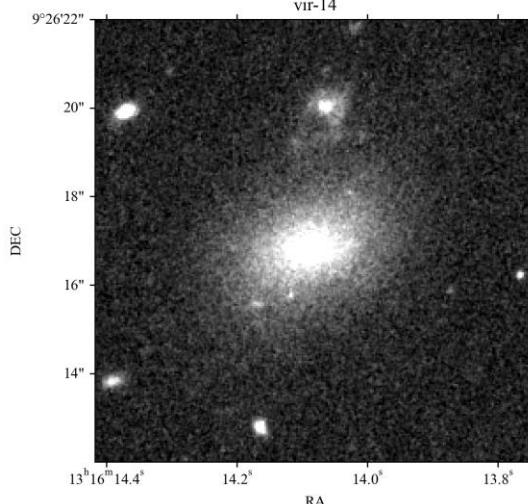
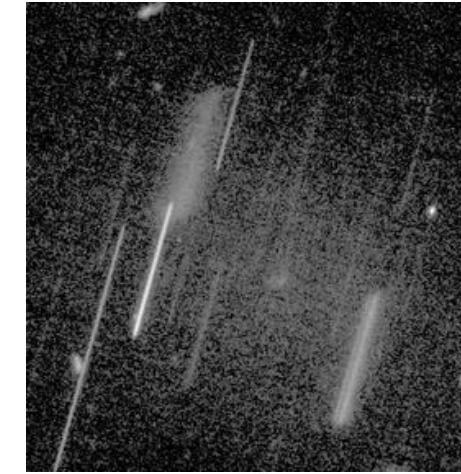
Goal of project

- 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

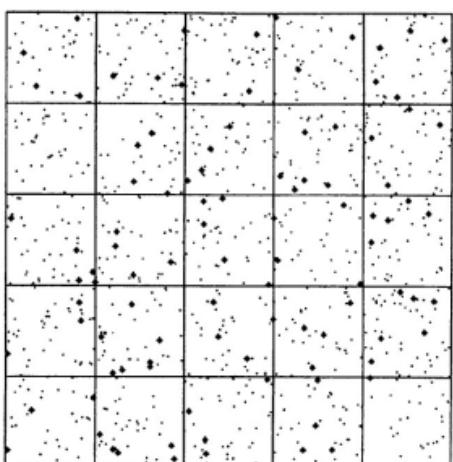
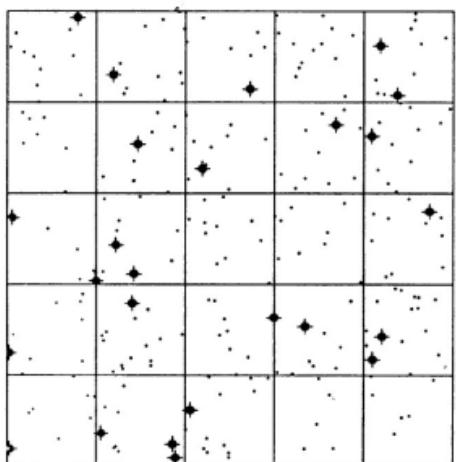
- Surface Brightness Fluctuation (SBF)



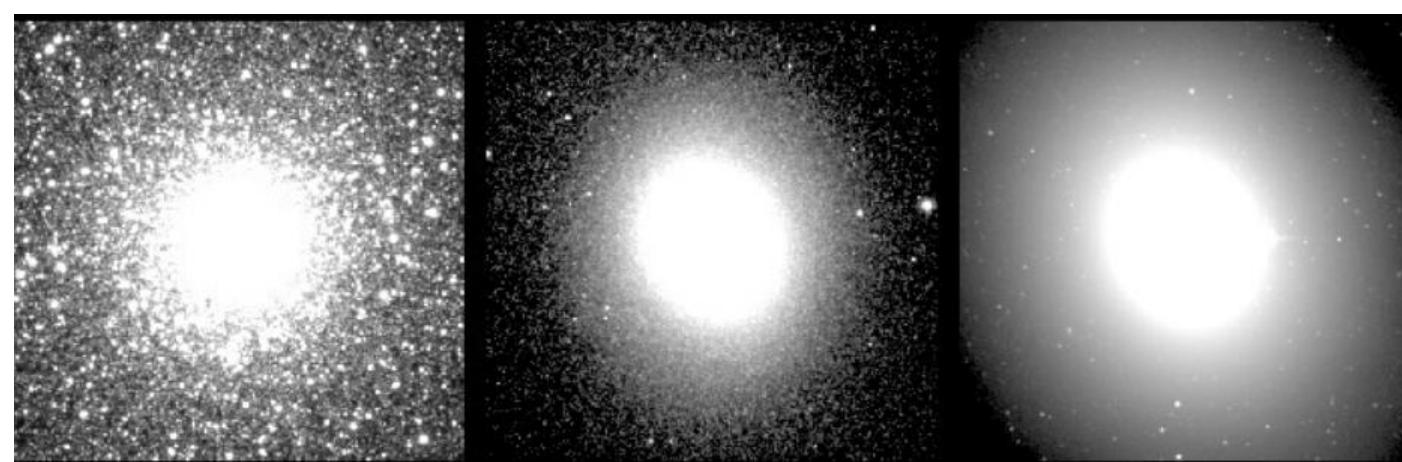
Surface Brightness Fluctuation (SBF)

Tonry & Schneider (1988)

Distance range: 10-100Mpc



Jacoby et al., 1992, PASP 104, 599

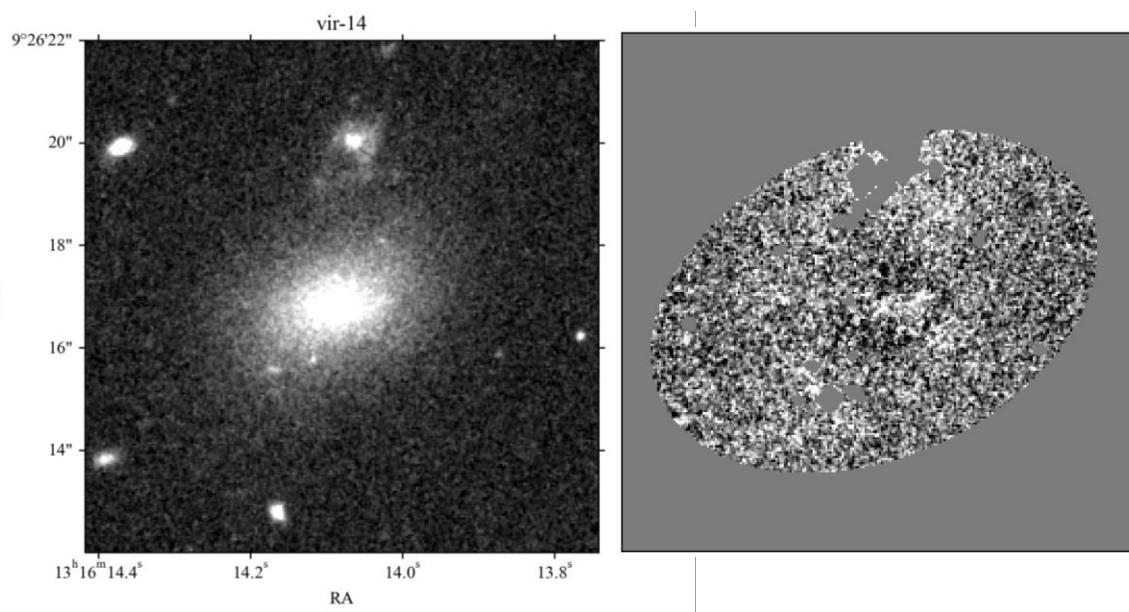


close

$$SBF \propto 1/d^2$$

far

Surface Brightness Fluctuation (SBF)



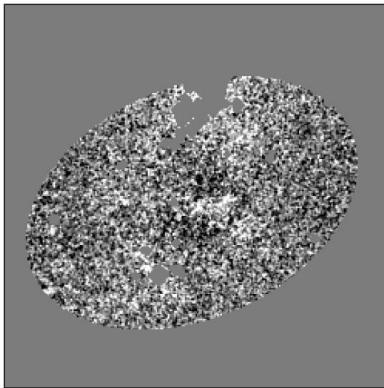
Data – non-SBF variance
(smooth galaxy profile, background, nearby objects)

Residual

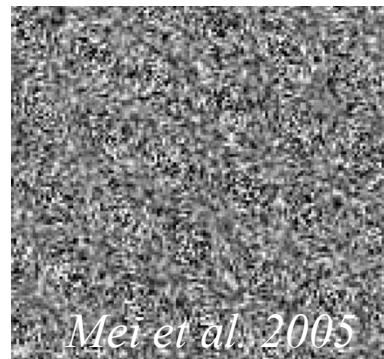
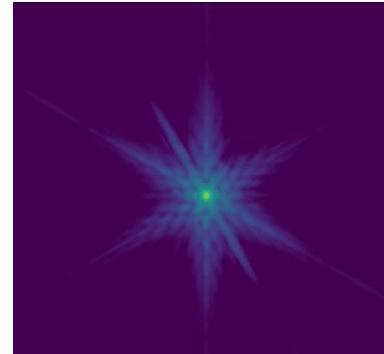
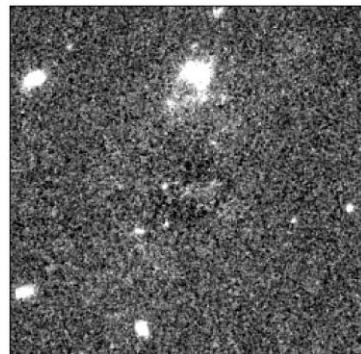
Image Space
= SBF + Noise

Fourier Space
= **SBF signal** × [PSF * Mask] + Noise

Surface Brightness Fluctuation (SBF)



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



Residual

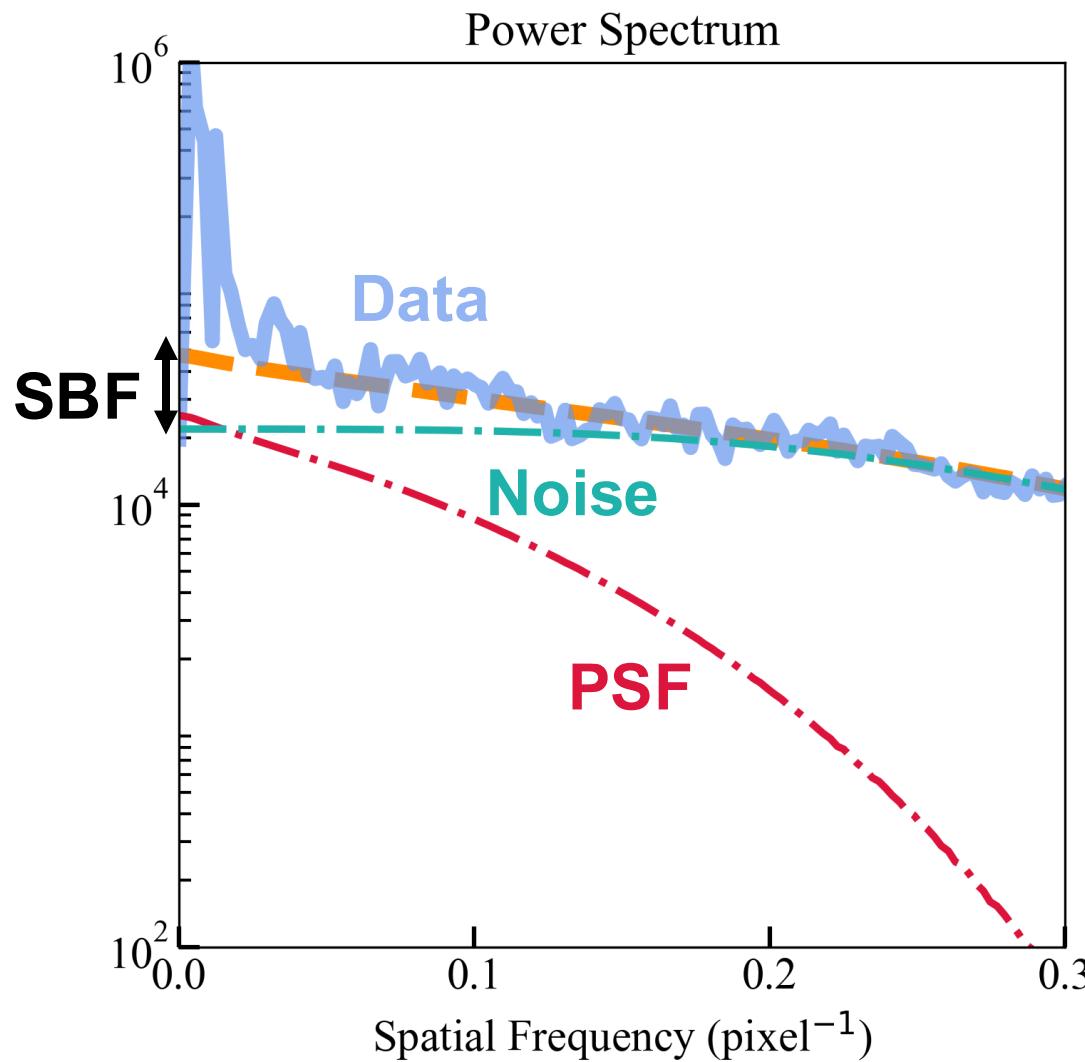
Image Space

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

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

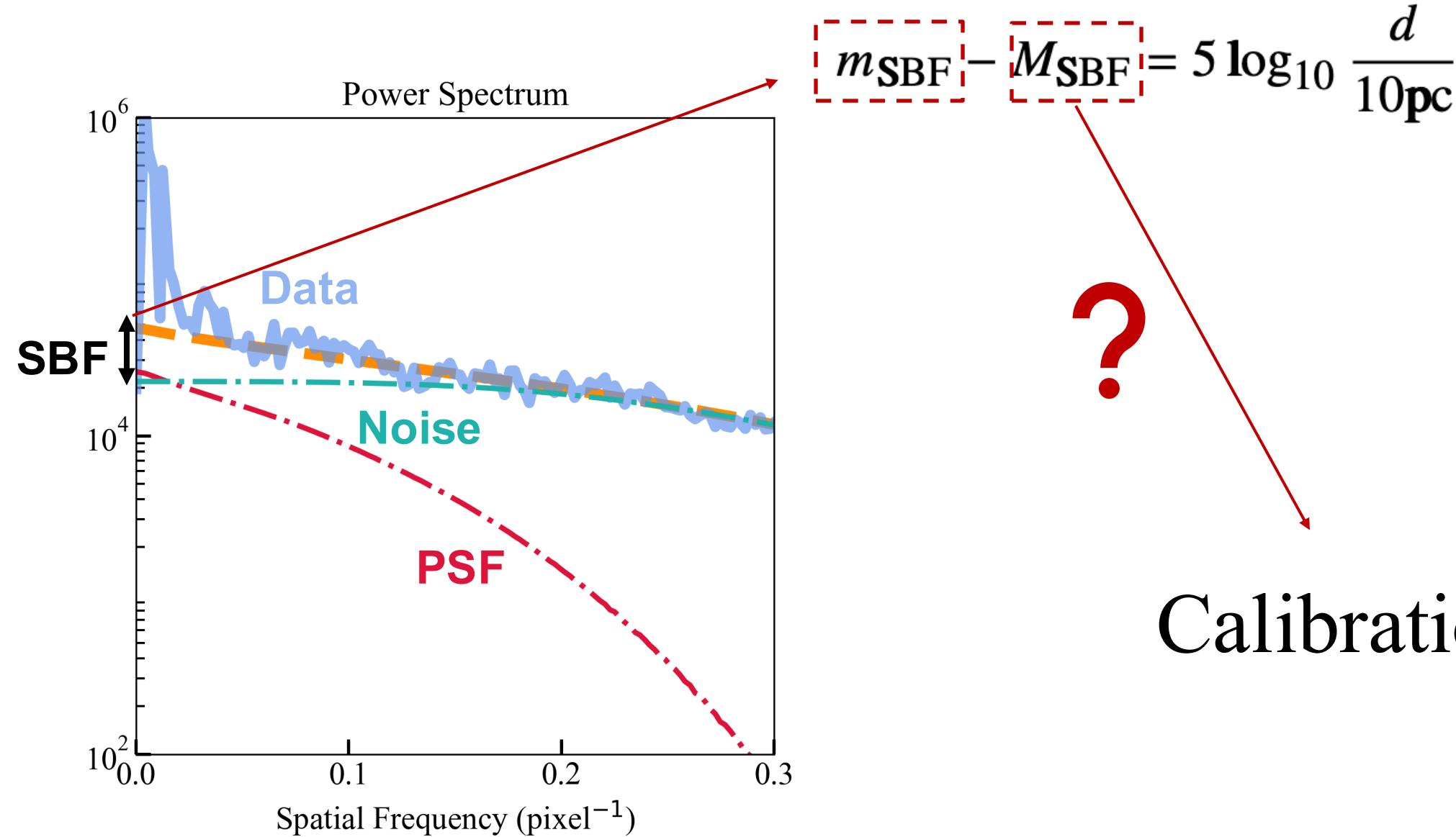
Image Space

= SBF + Noise

Fourier Space

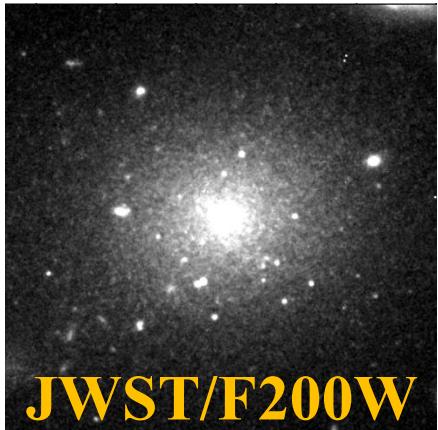
= **SBF signal** \times [PSF * Mask] + Noise

Surface Brightness Fluctuation (SBF)

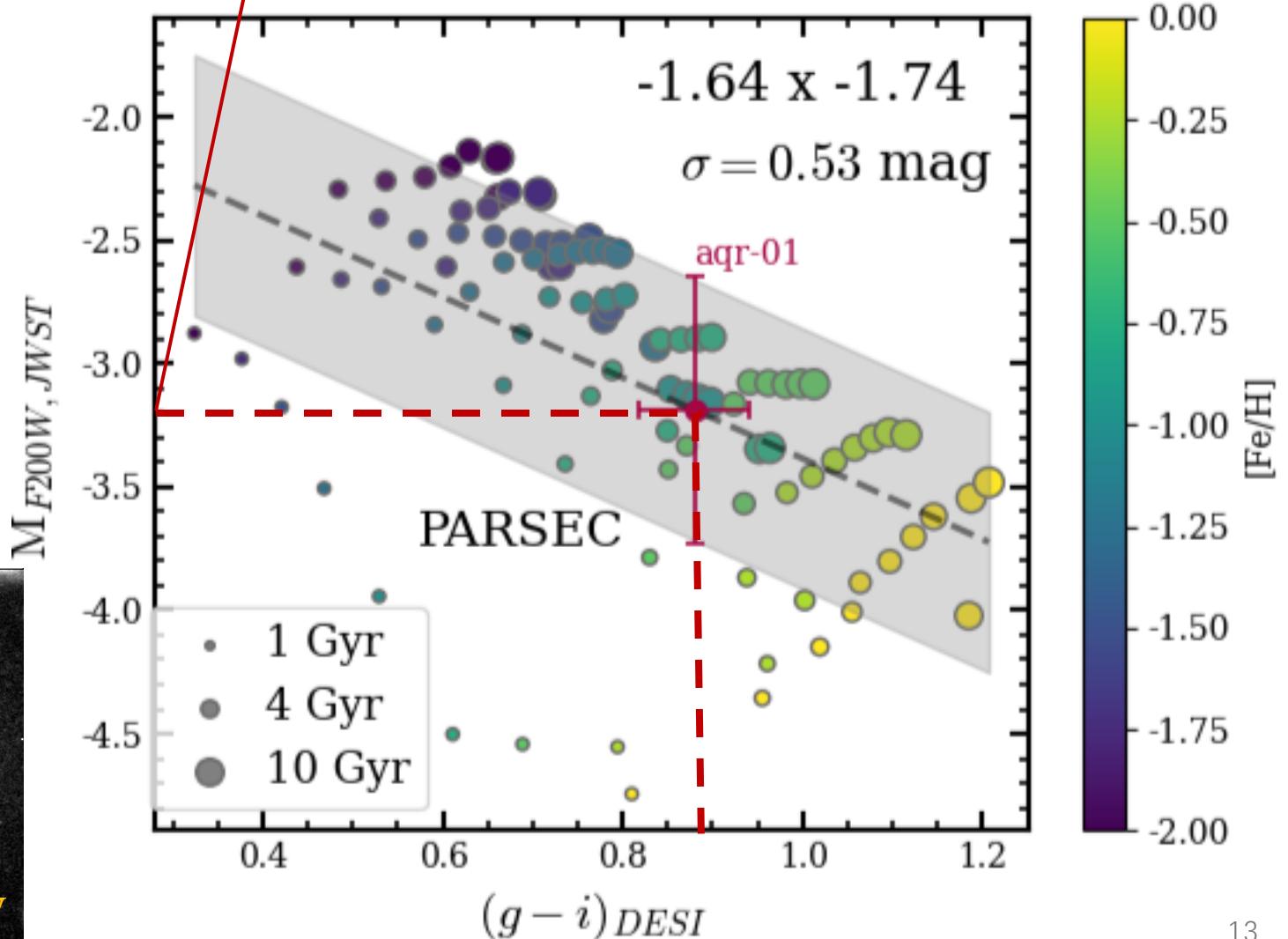


Calibration

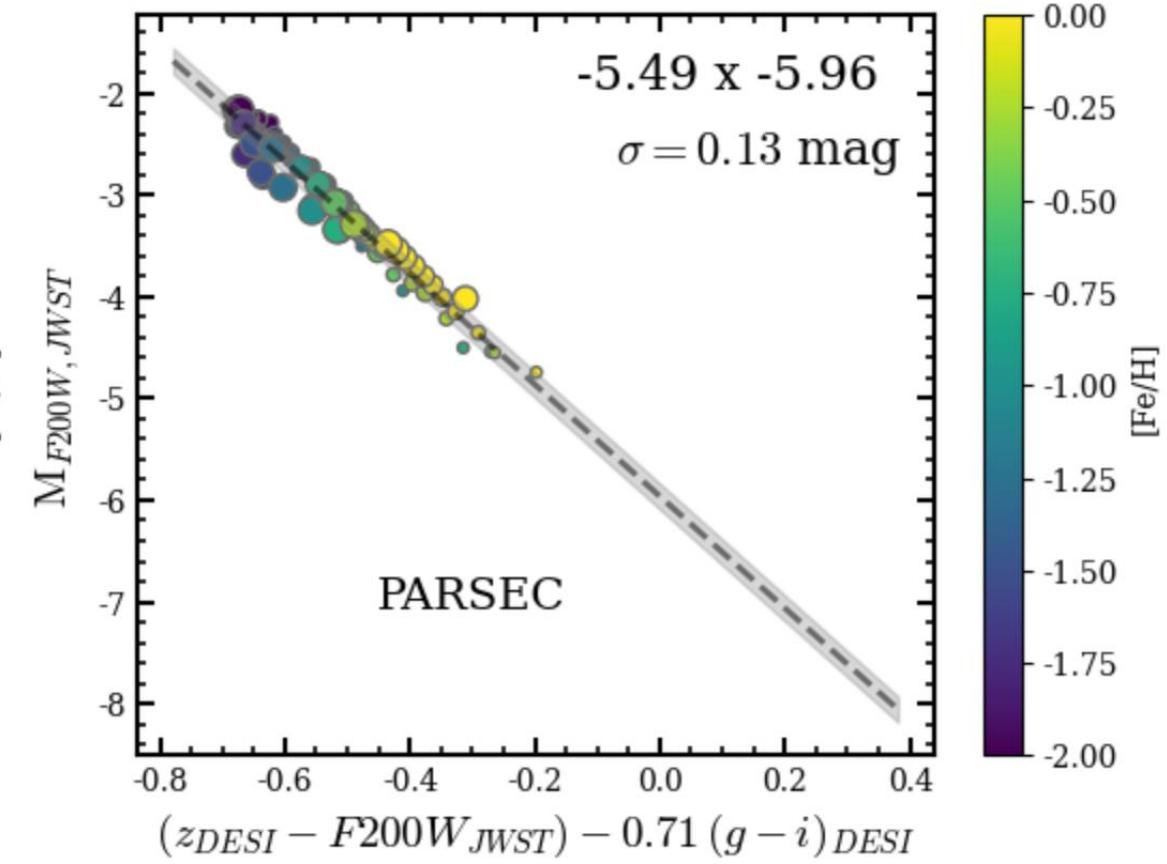
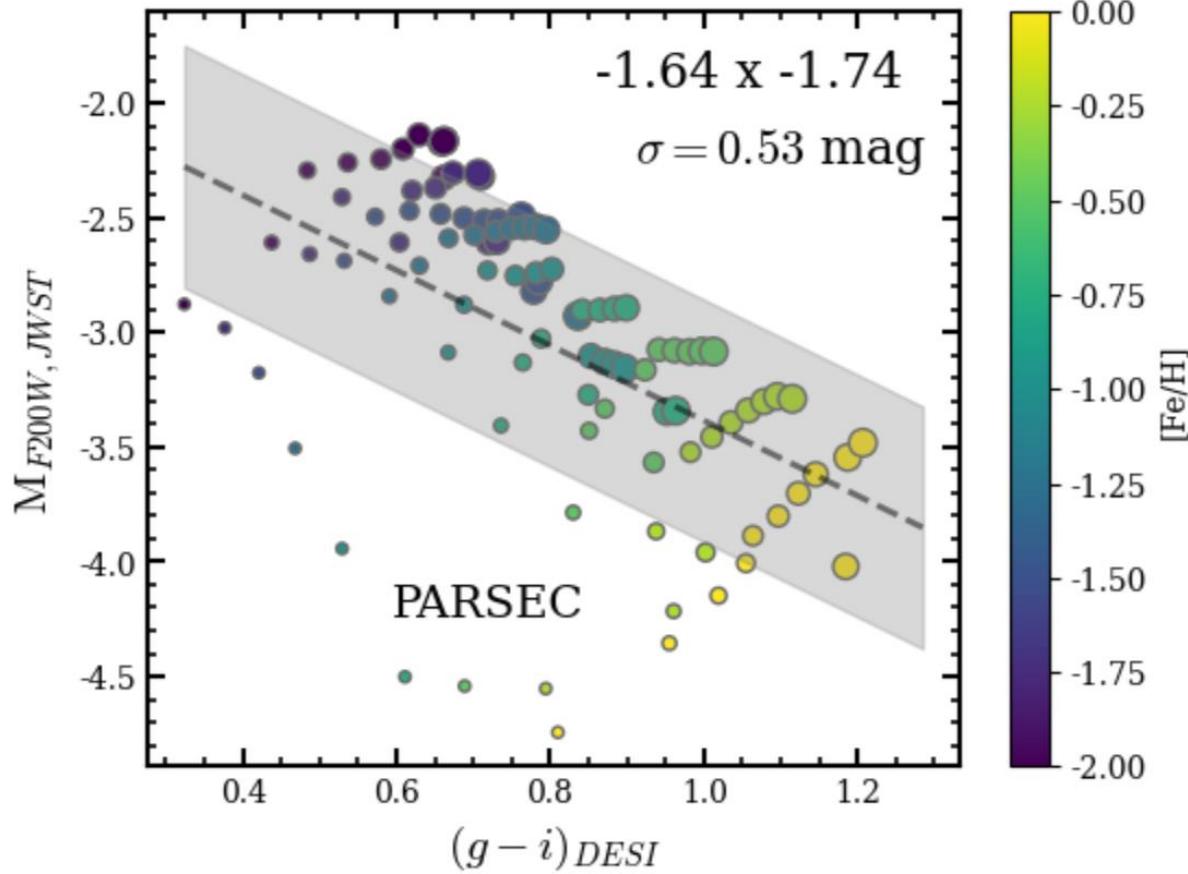
- M_{SBF} varies with metallicities & ages
- No calibration in JWST F200W.
- Stellar population synthesis Model



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

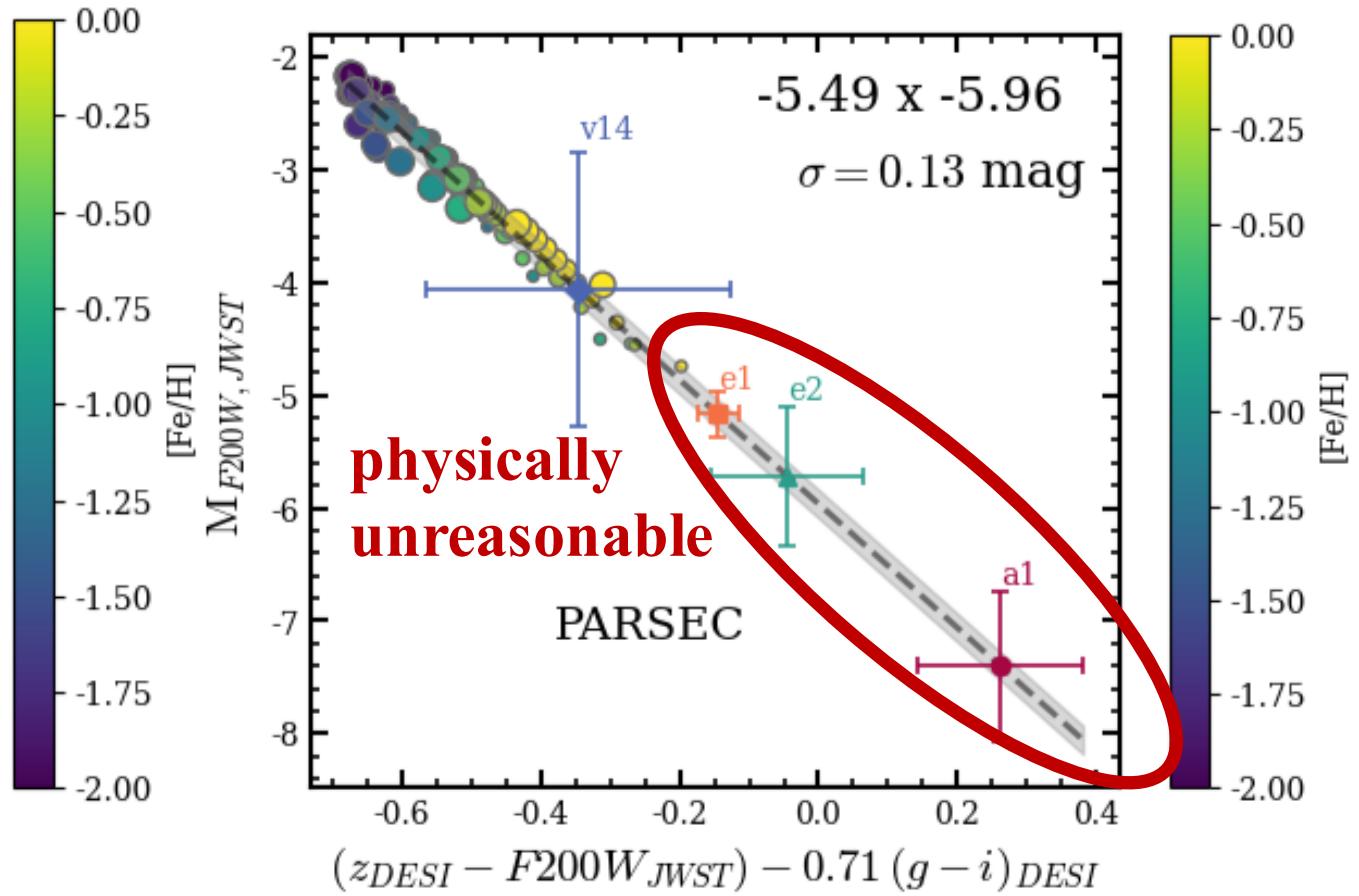
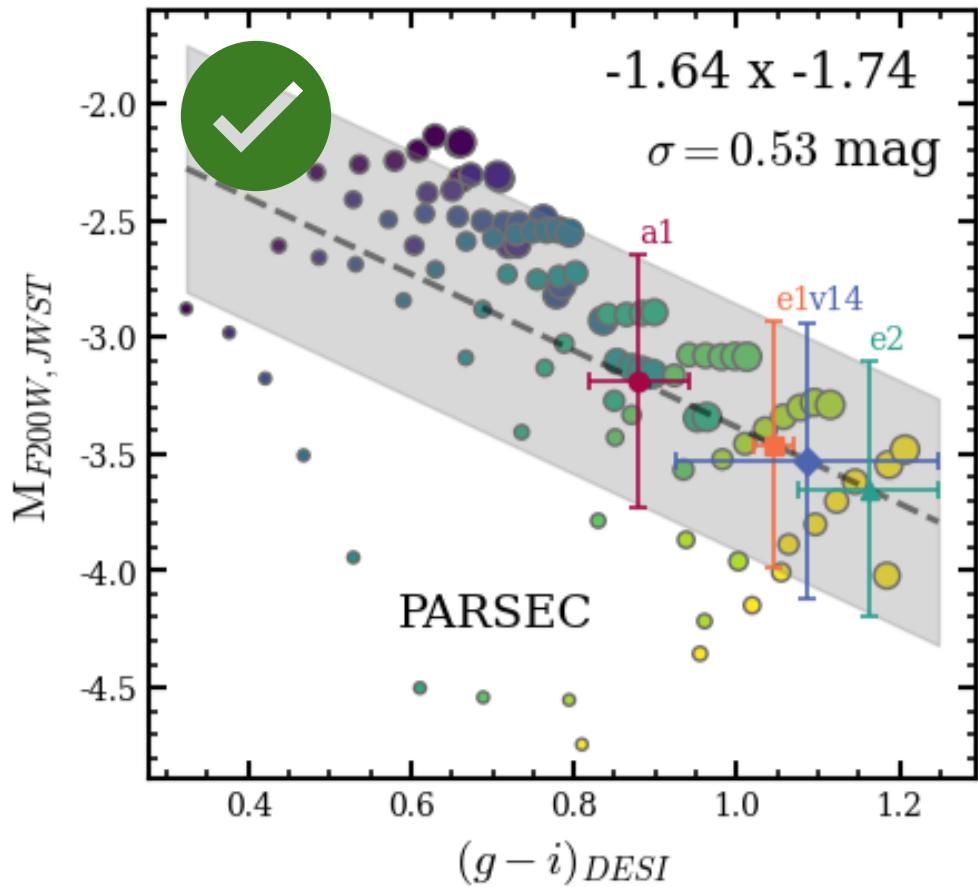


Calibration



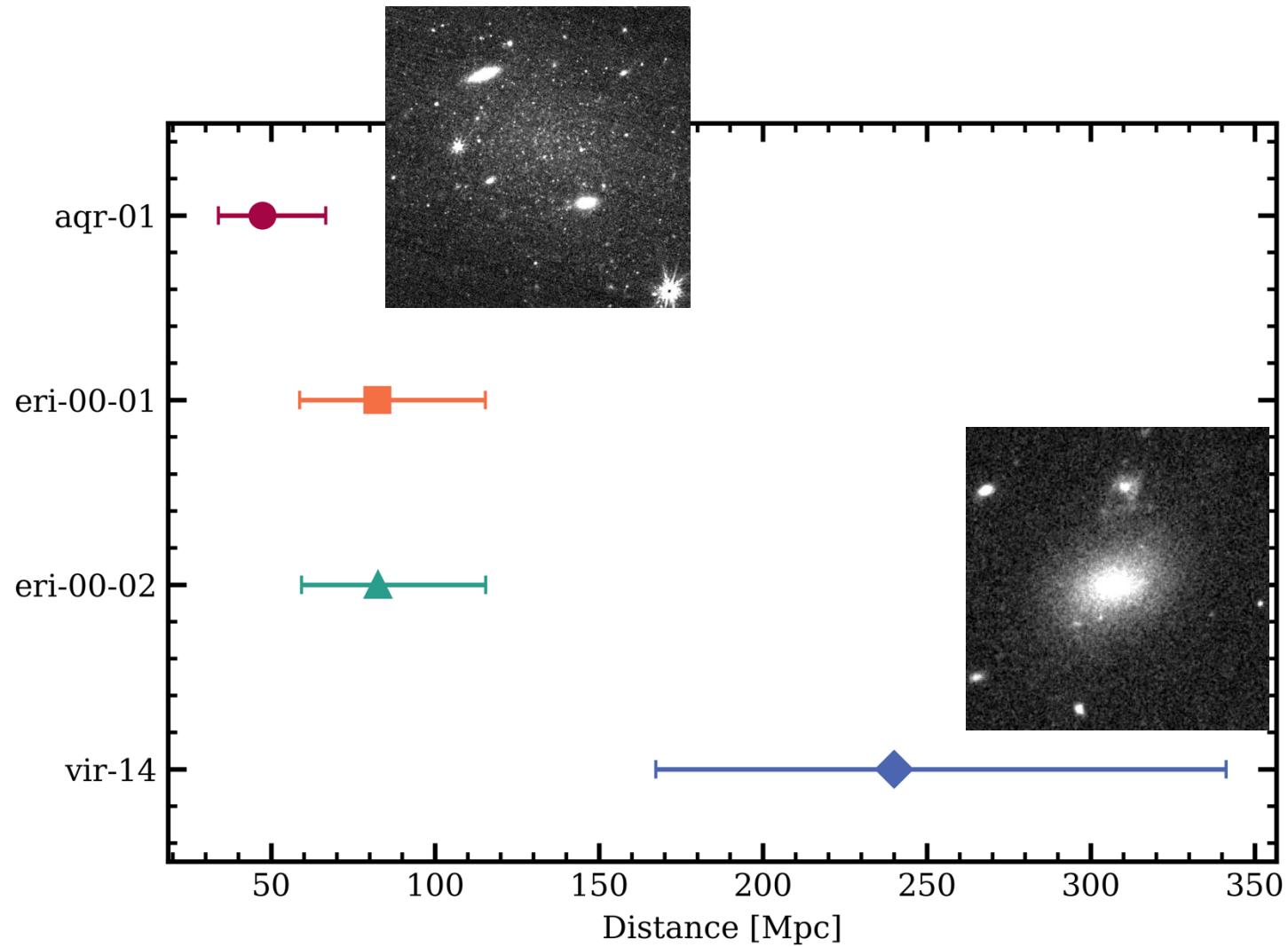
Calibration

ZP / Photometry issue...



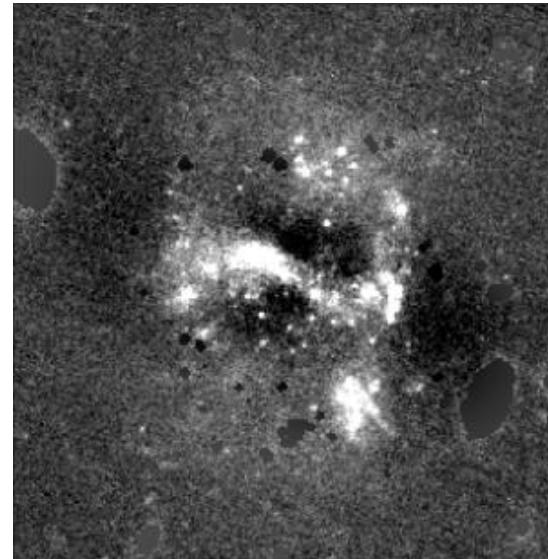
Distance

Galaxy	$(g - i)_{DESI}$
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

