Extended low surface brightness halos around massive galaxies in nearby universe

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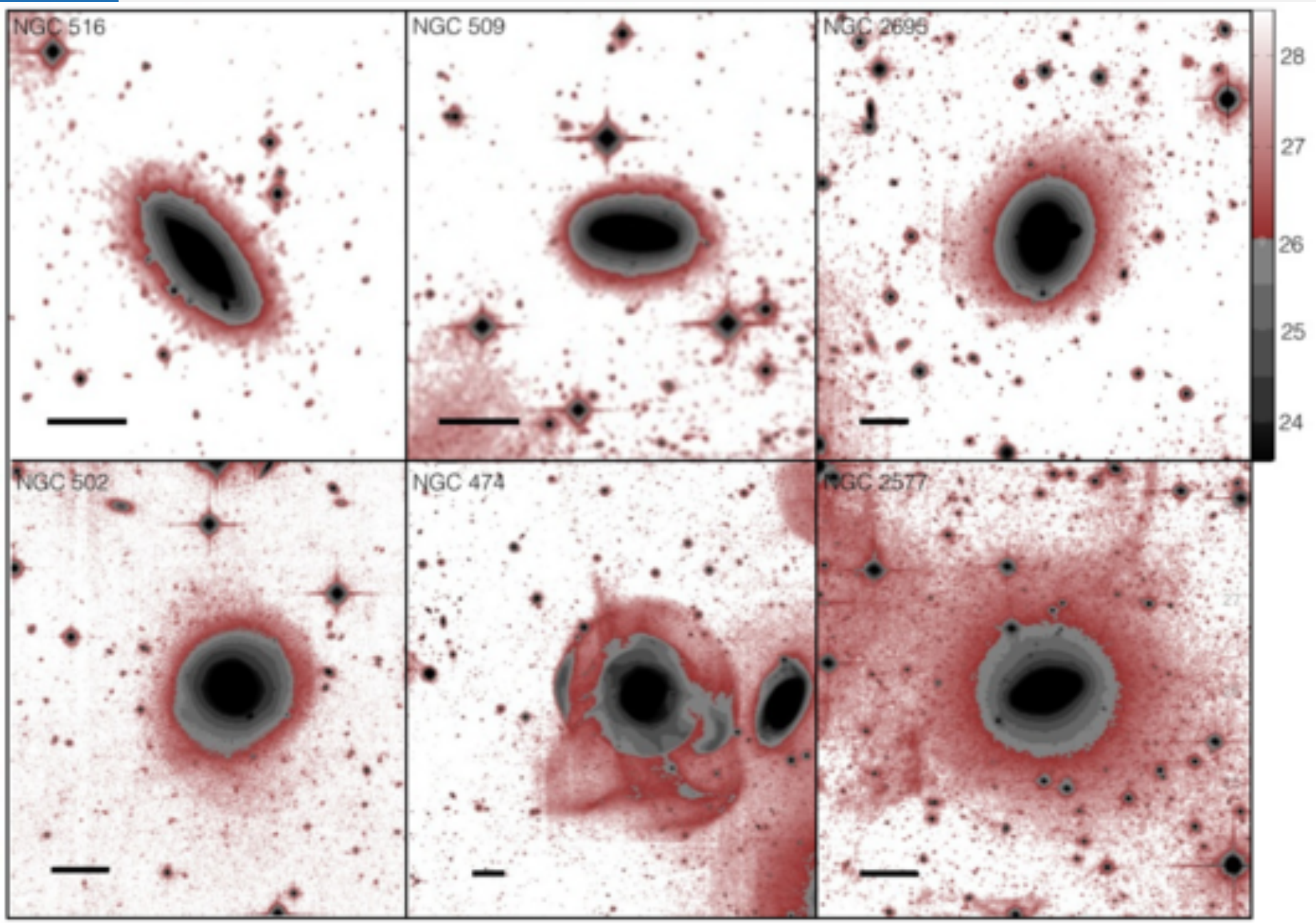


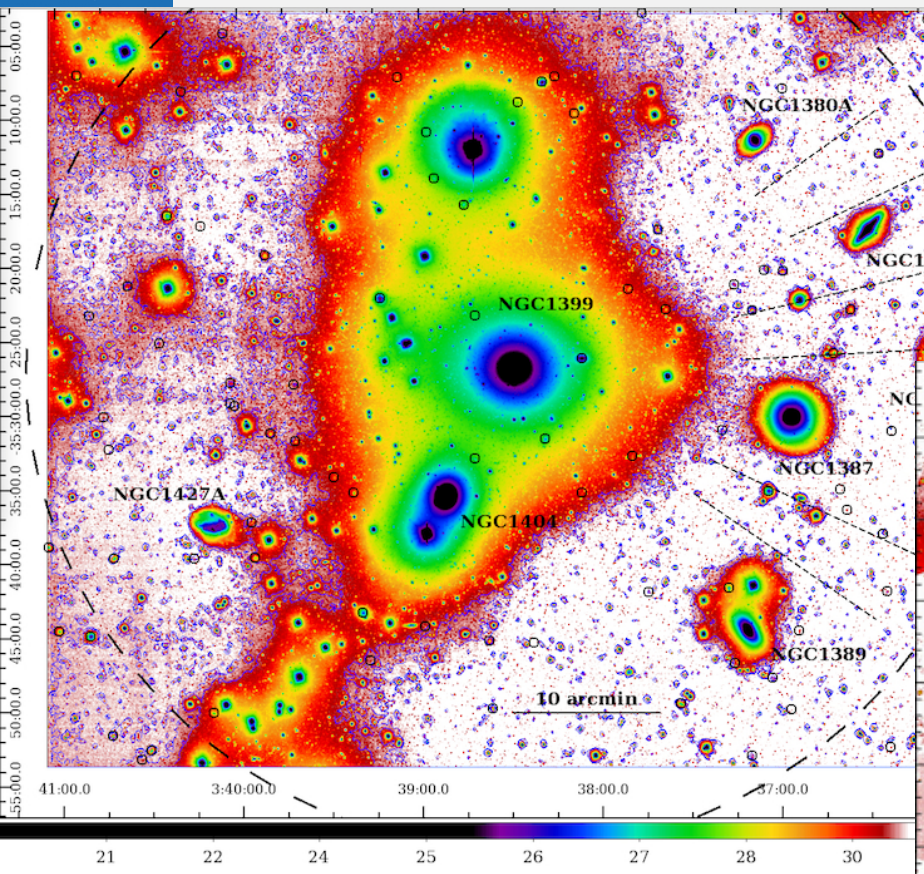
Duc et al. 2015: ATLAS3D – low surface brightness envelopes in field nearby galaxies

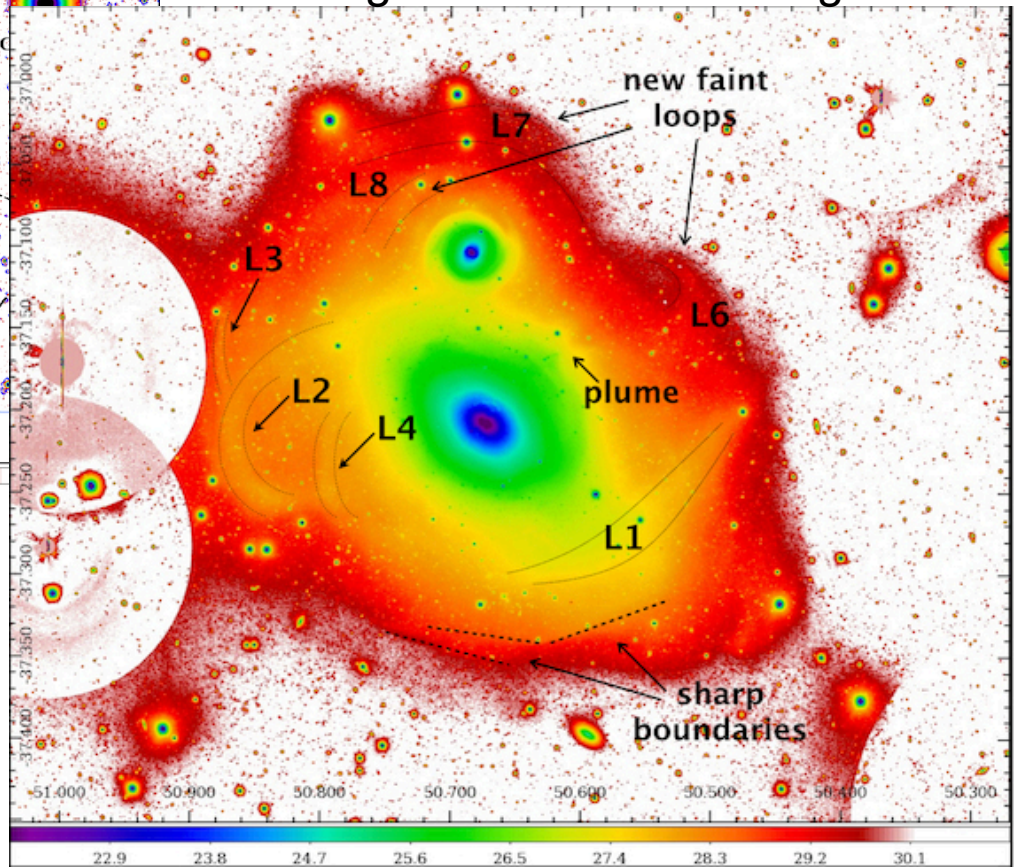
“Fornax is becoming the new Virgo”

Luca Cortese, Monday

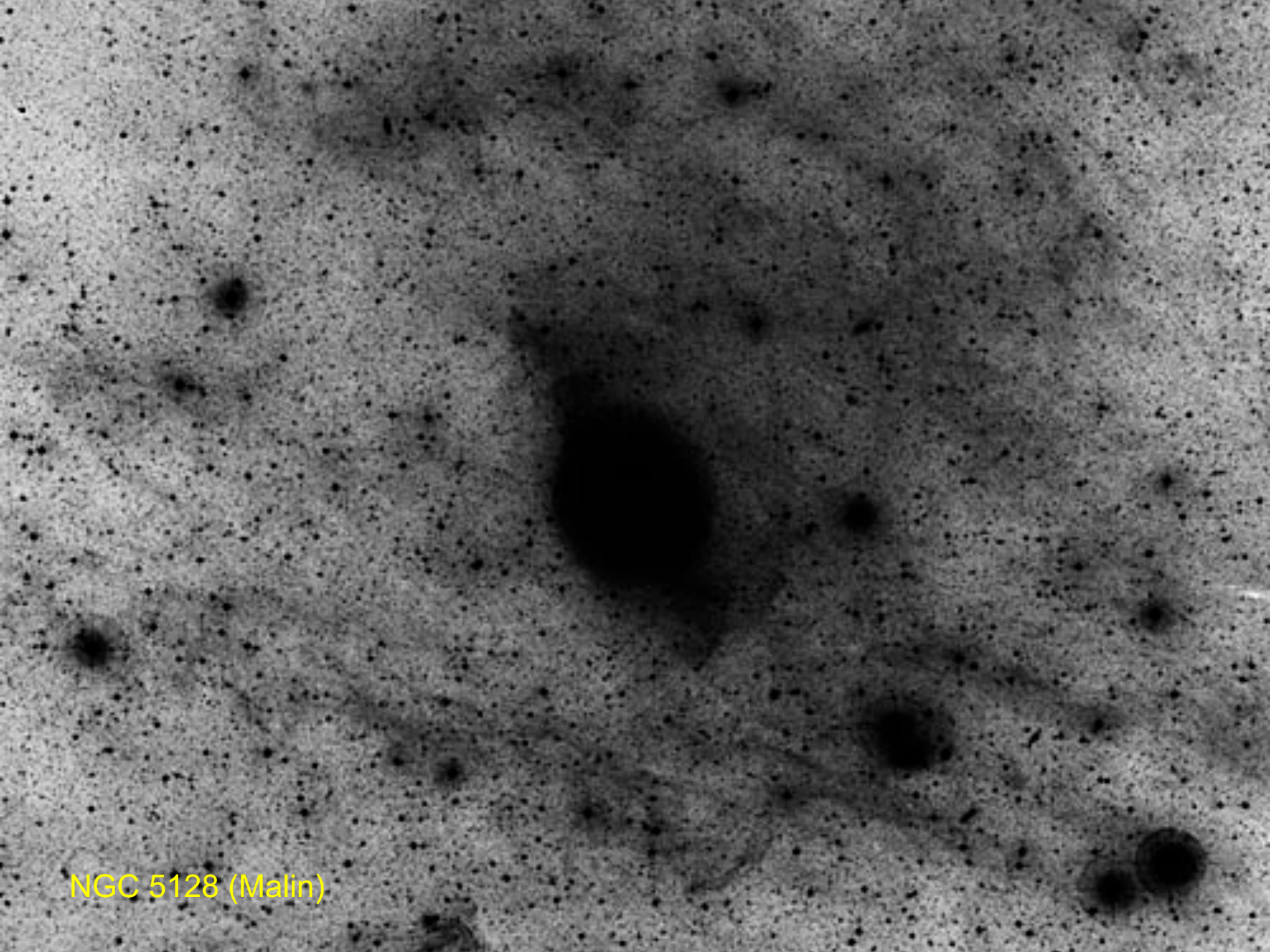
Also: **VEGAS** (Spavone et al. 2017)

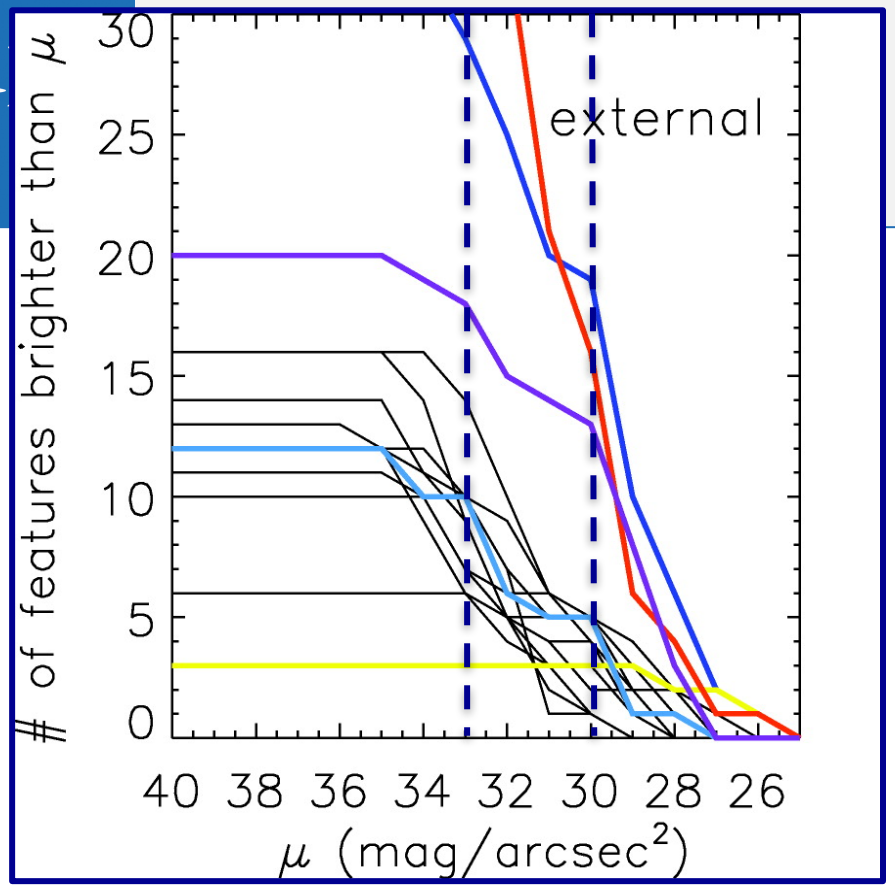
Iodice+2017: **NGC 1316** 6×10^{11} $M_\odot$
New faint loops 29-30 mag/arcsec^2
Exponential halo ~ 40% of light
Color gradient to blue: 0.7<g-r<0.4

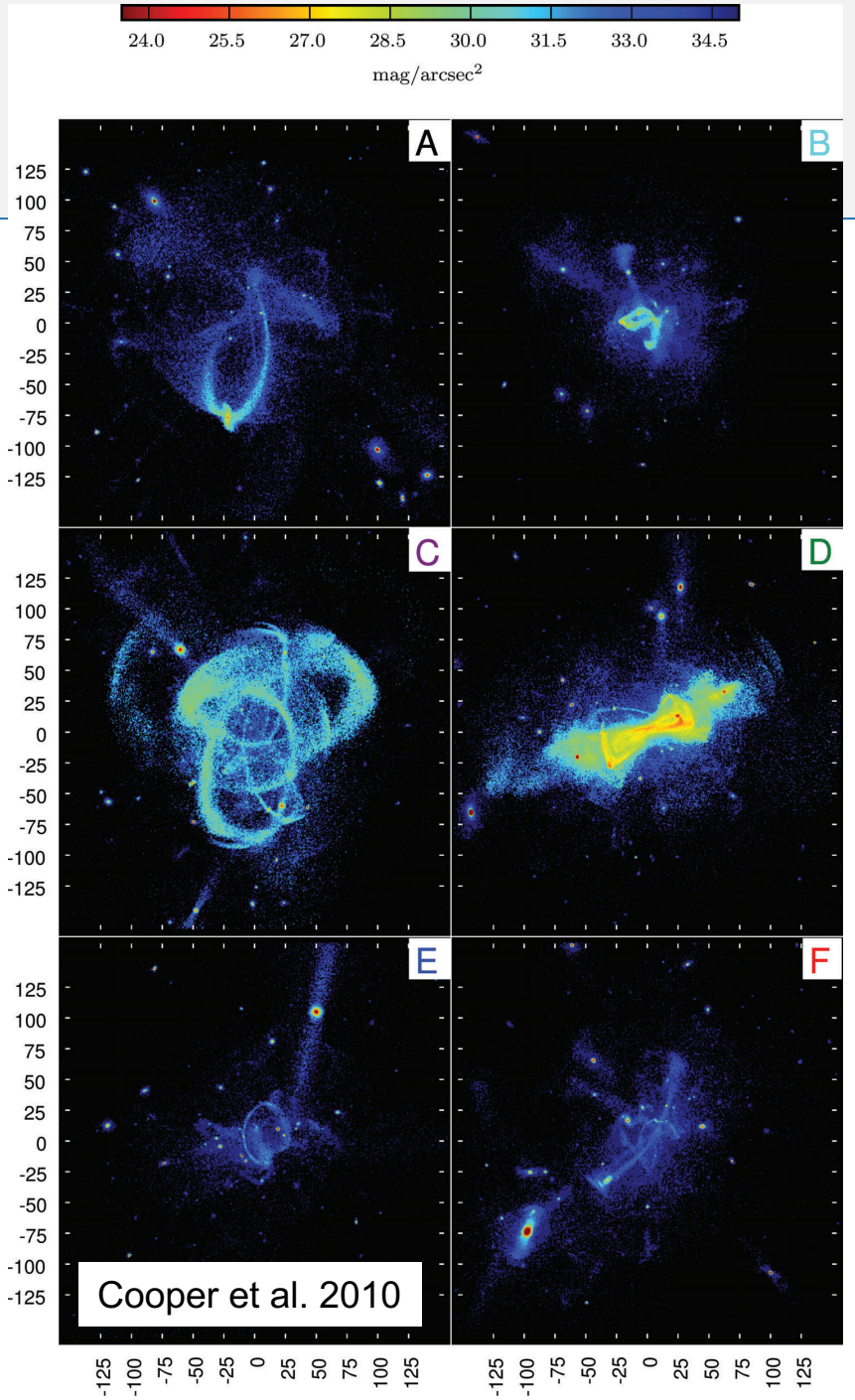




Iodice+2016: **NGC 1399** 7×10^{12} $M_\odot$
Bridge between N1387 & N1399
Exponential halo ~ 60% of total light
Flat color gradient g-r ~0.8 mag (3-6 R_e)


NGC 5128 (Malin)





Johnston et al. 2008:

A MW type galaxy halo hosts
~ 2 features SB<30 mag/arcsec^2
~10 with SB<33 mag/arcsec^2

Most features are between
30-33 mag/arcsec^2

Resolving Stellar Halos

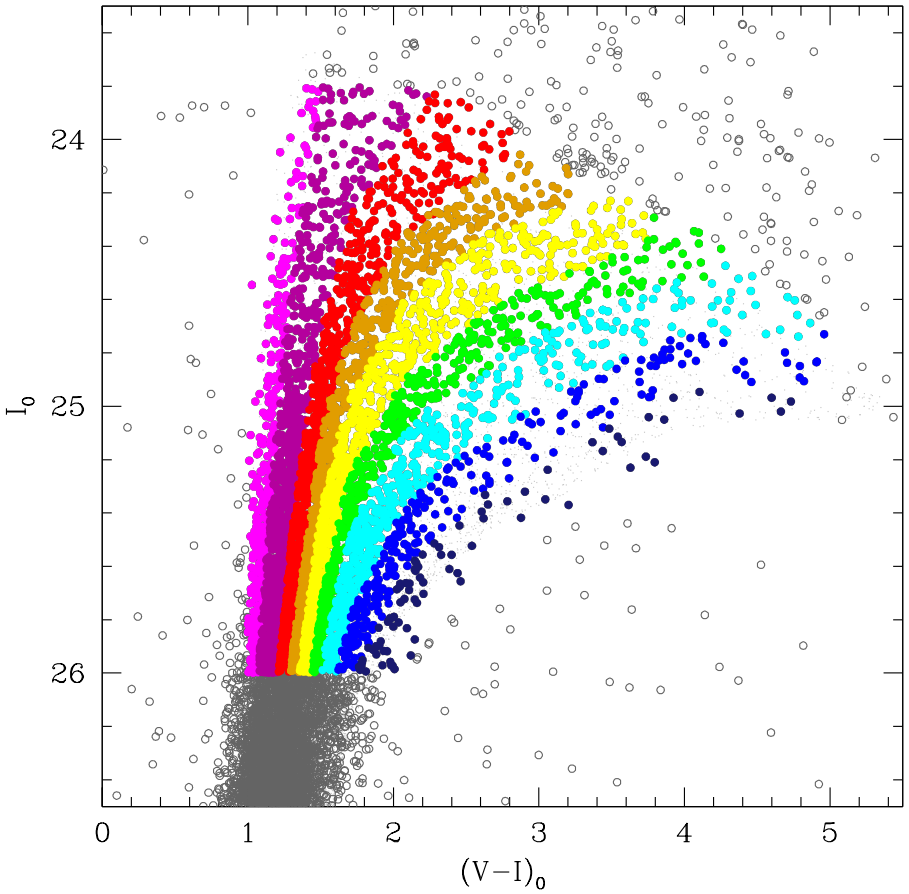
Limitations

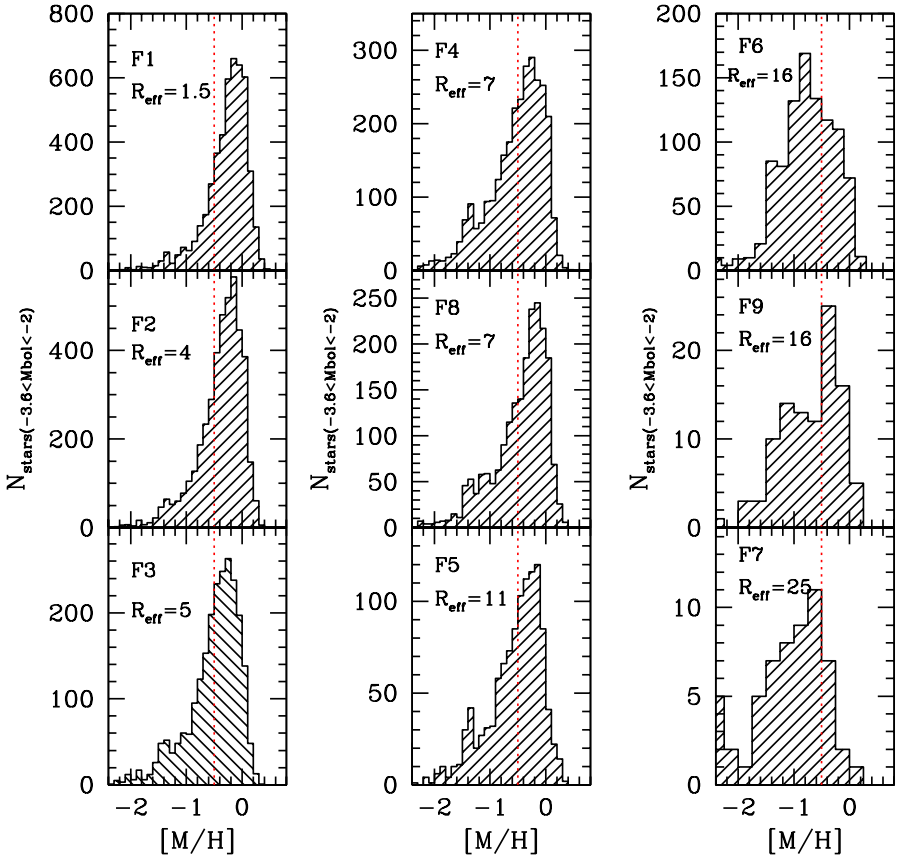
- Nearby galaxies: <5-10 Mpc (ground); <20 Mpc (HST)
- Foreground/background contamination
- Requires high spatial resolution (compact galaxies contamination)
- Small samples and limited coverage for large nearby galaxies

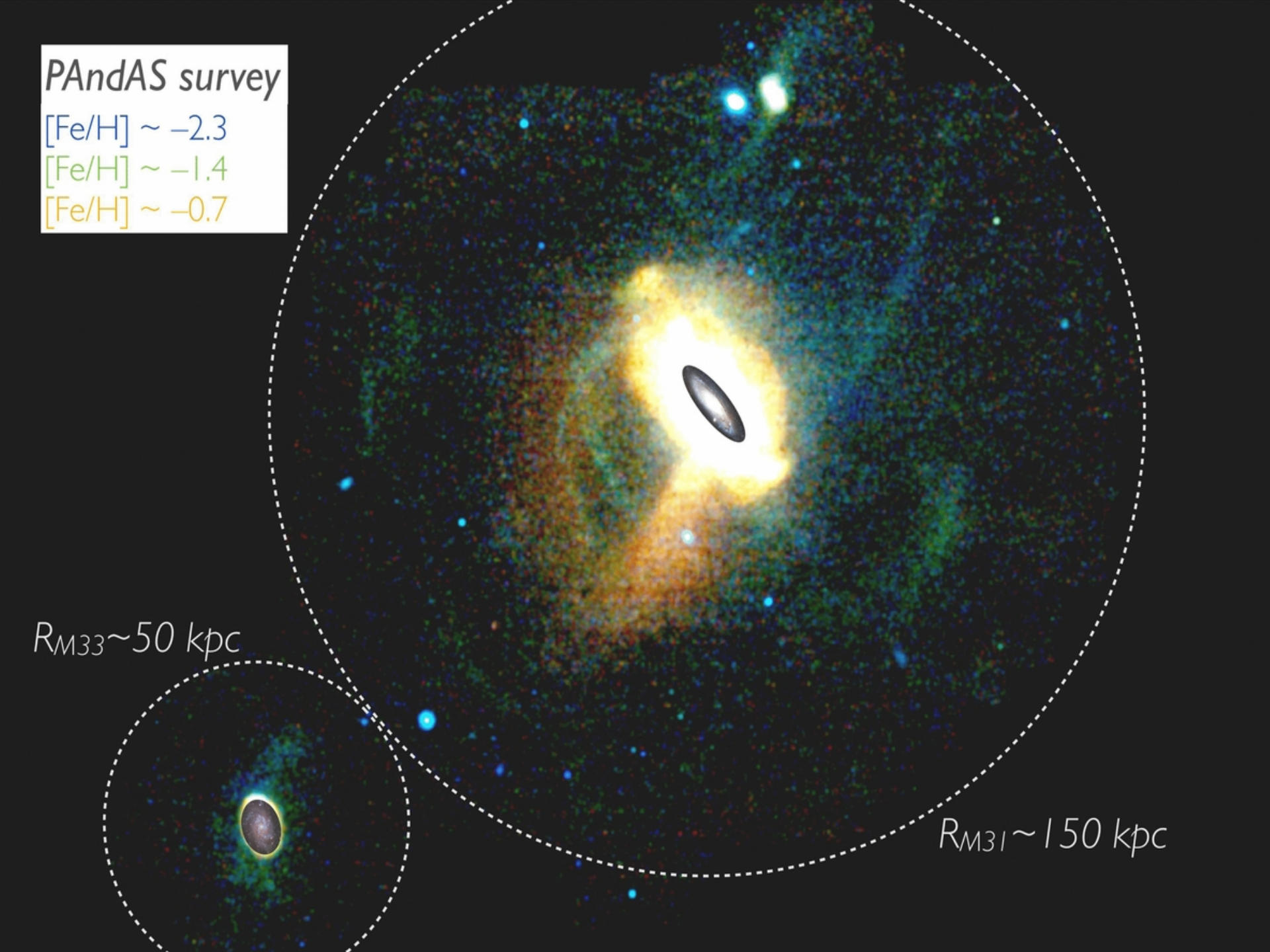
Advantages

- ✓ Flat-fielding, sky subtraction, cirrus
- ✓ Unambiguous detection; surface density profile
- ✓ Old accretion events & sub-structures to μ_V~33 mag/arcsec^2
- ✓ Stellar population constraints:
  - ✓ metallicity ***distribution & gradients***
  - ✓ ***Age (?)***
- ✓ Globular cluster system

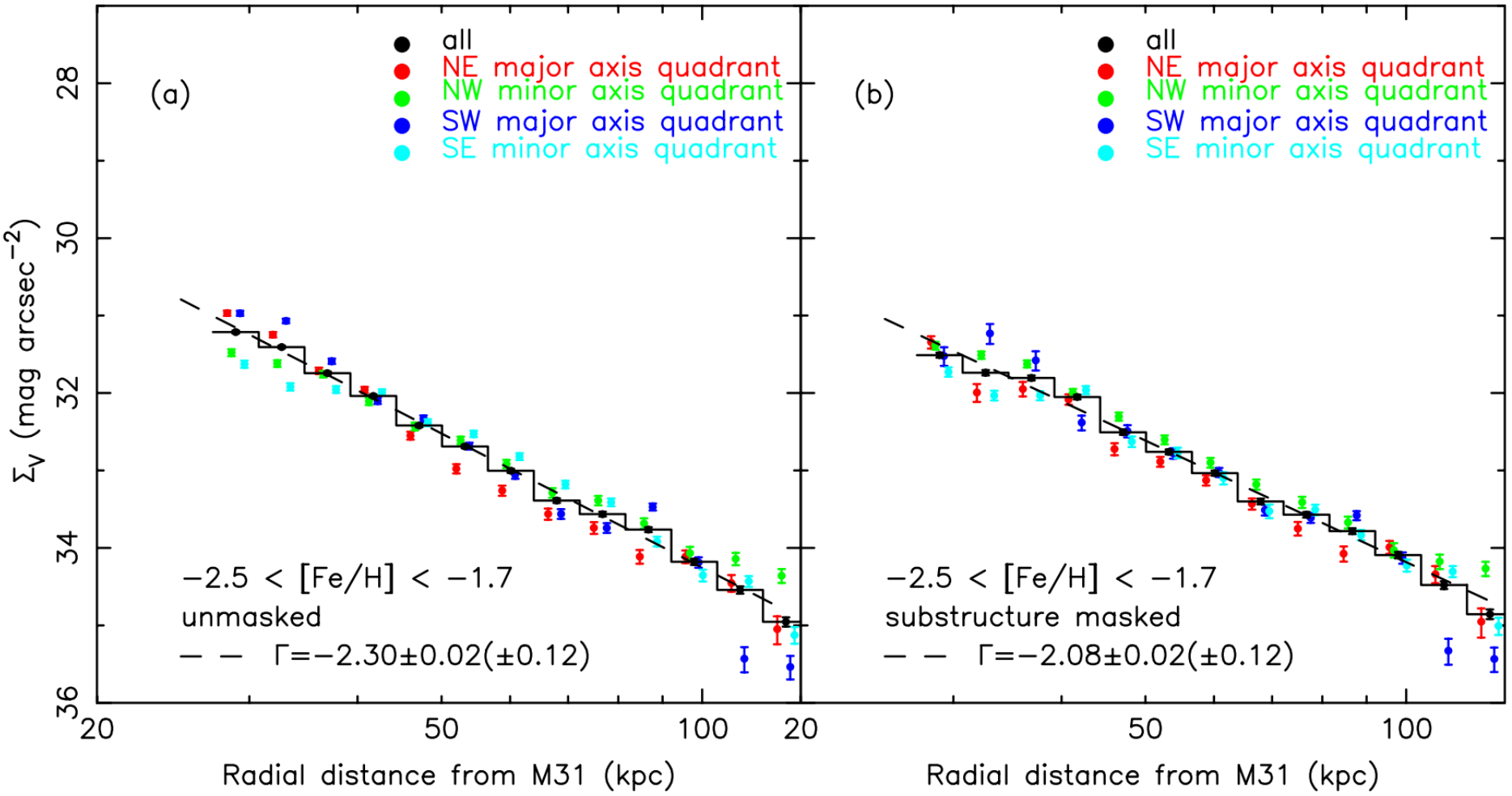
Old red giant stars in the halo






PAndAS survey
[Fe/H] ~ –2.3
[Fe/H] ~ –1.4
[Fe/H] ~ –0.7
R_{M33}~50 kpc
R_{M31}~150 kpc

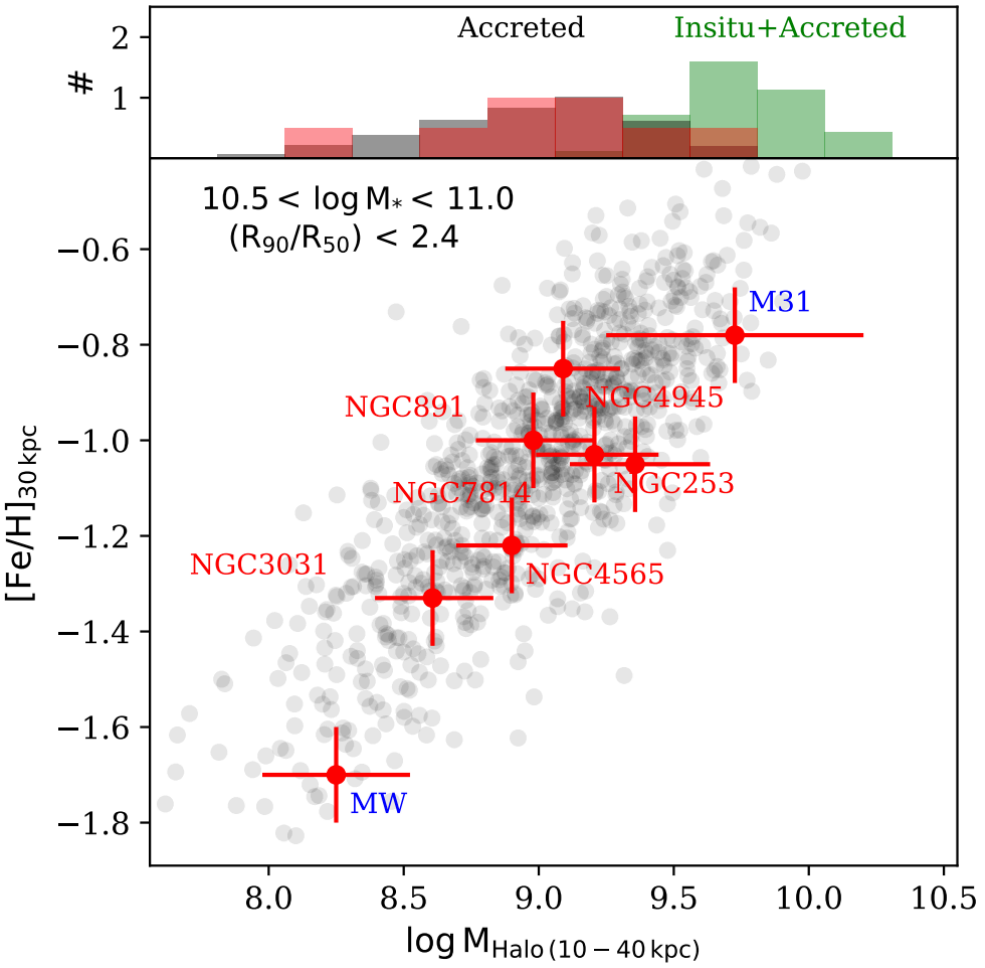
PAndAS survey

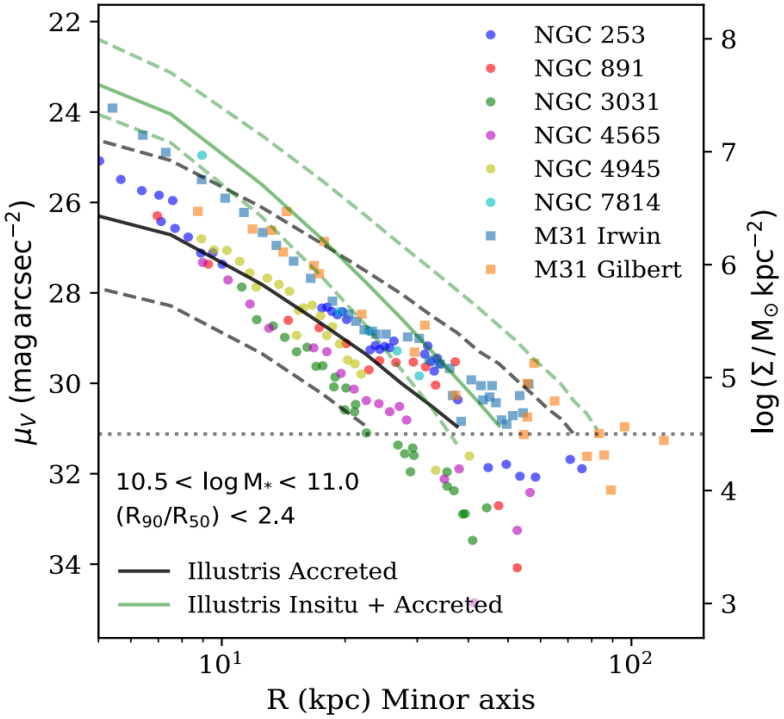


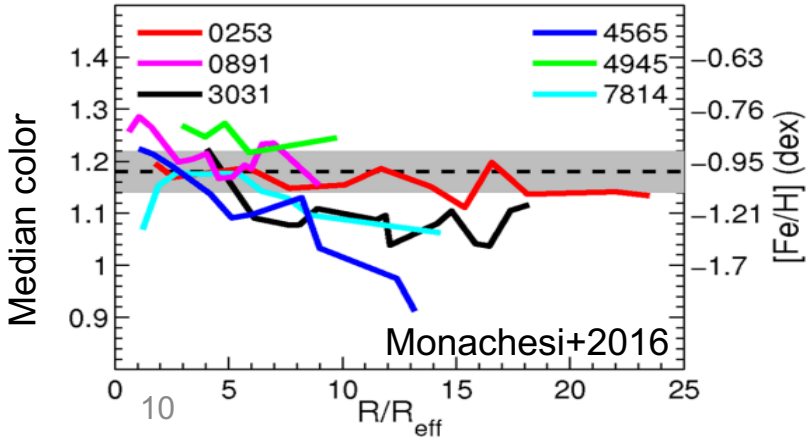
Ibata et al. 2014

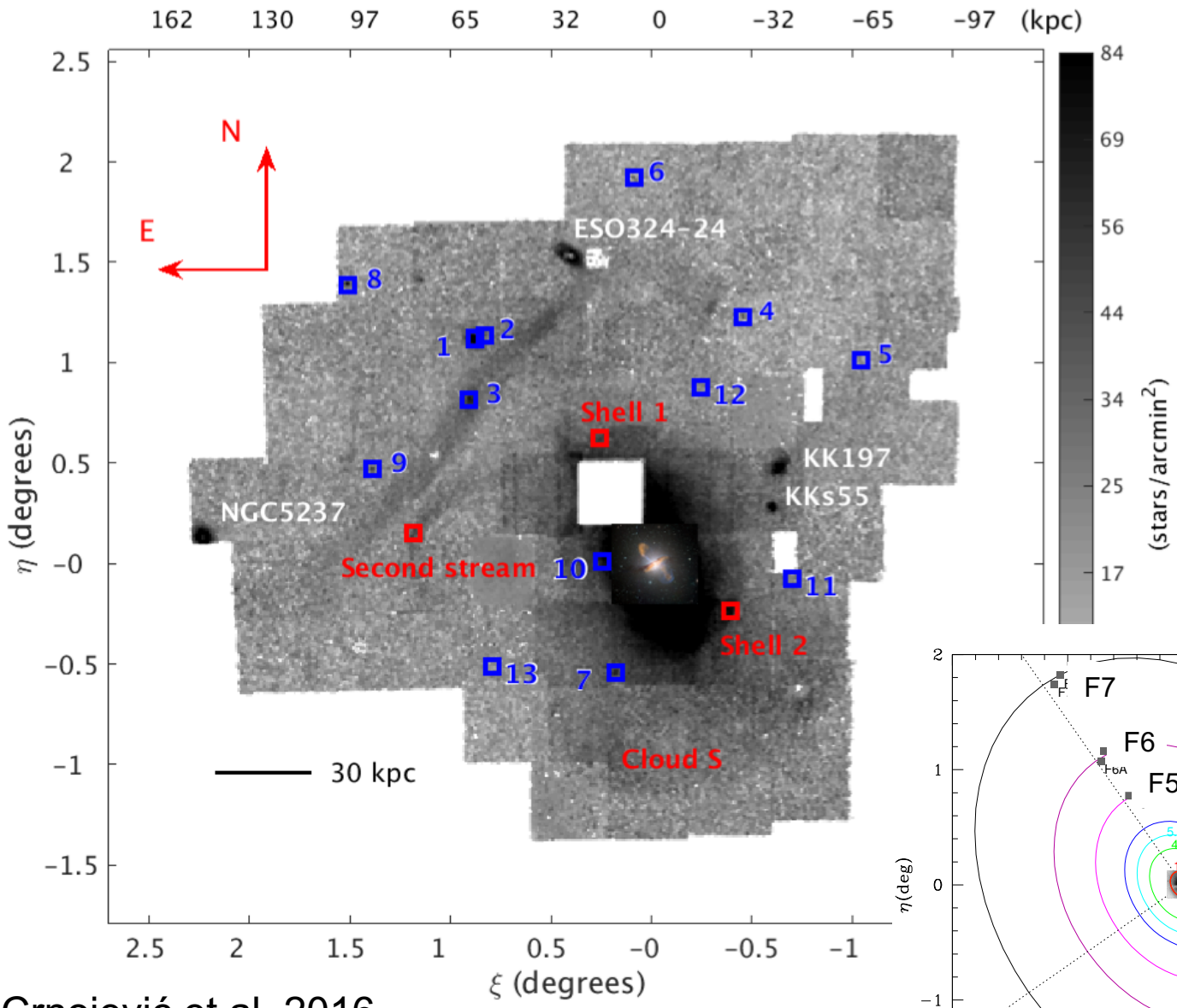
Halo stellar mass – stellar metallicity

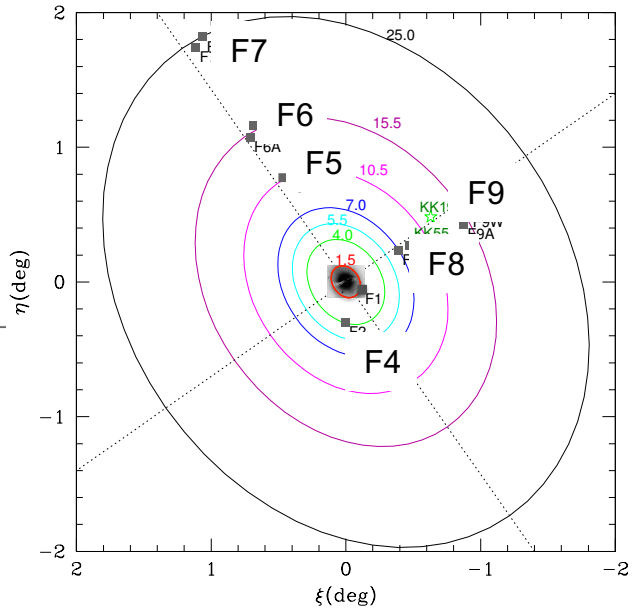
D'Souza & Bell 2017





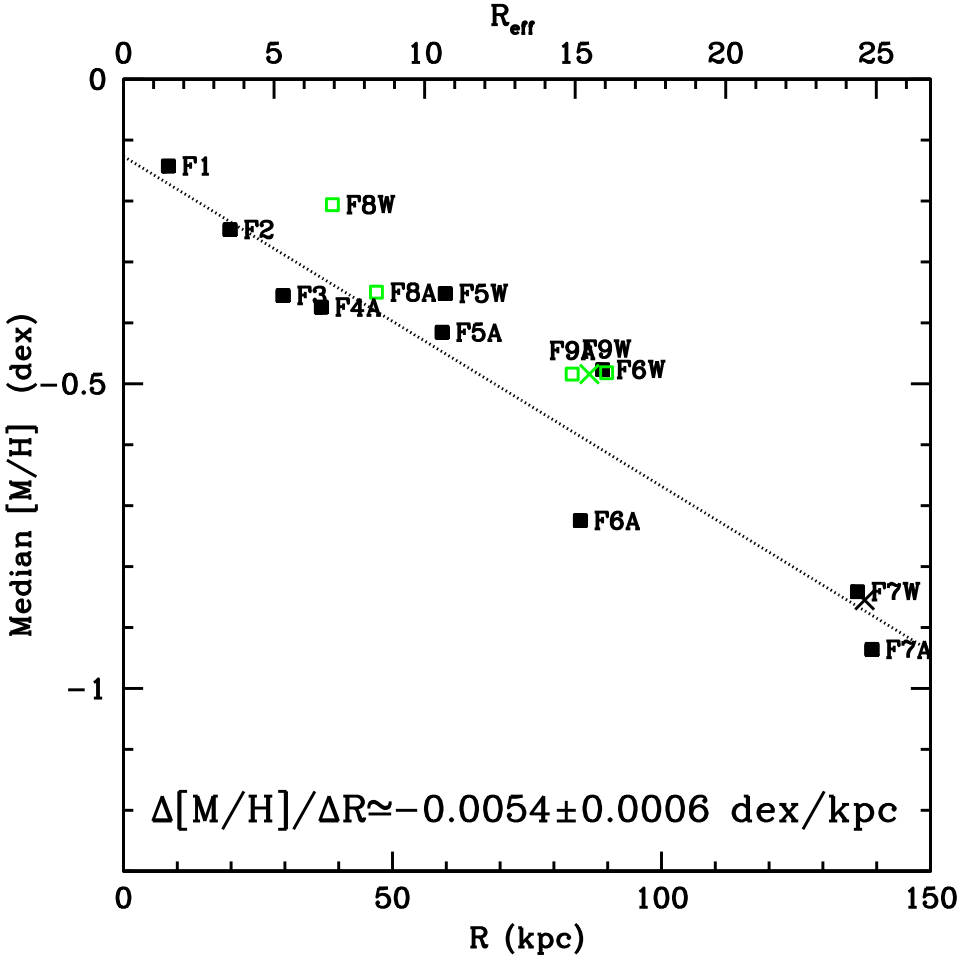


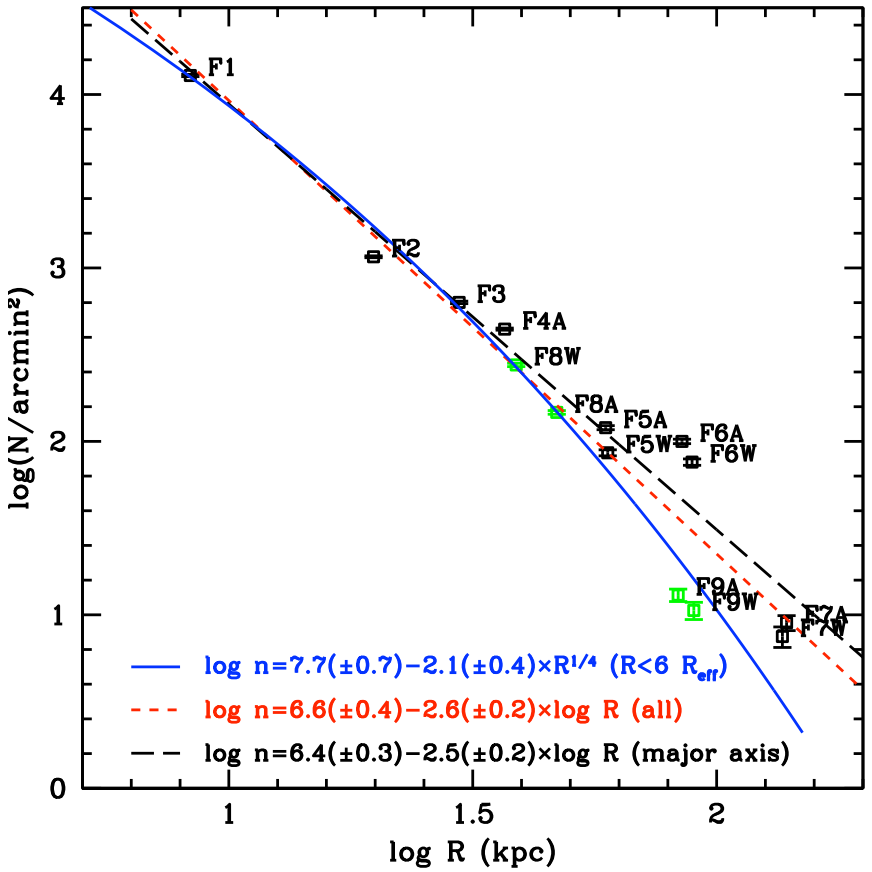




Crnojević et al. 2016

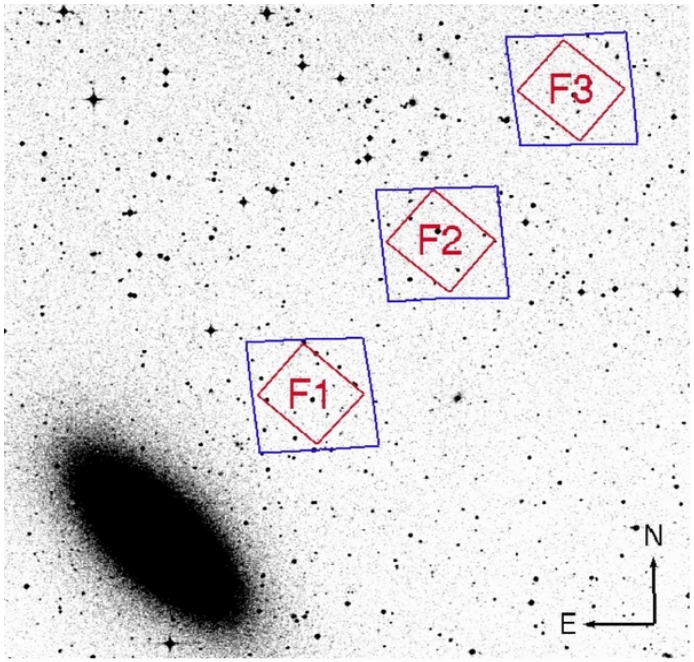
NGC 5128/Cen A Stellar Halo: Density and Metallicity gradients

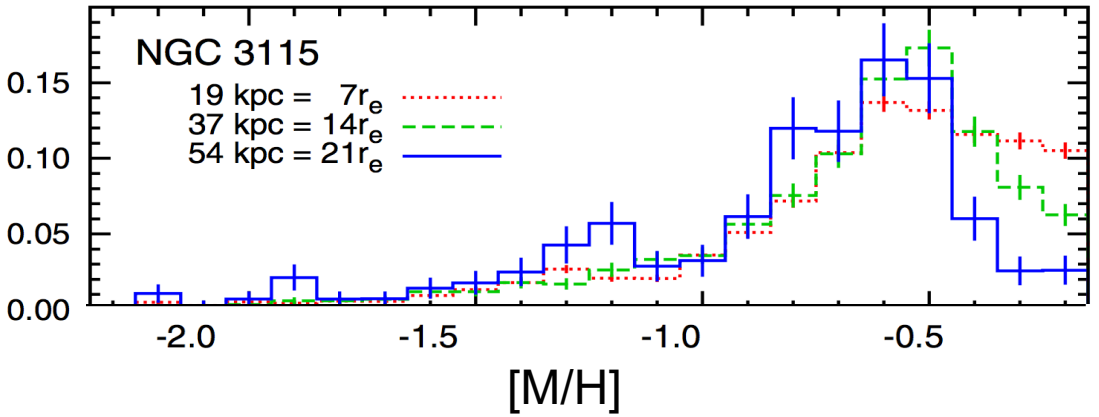


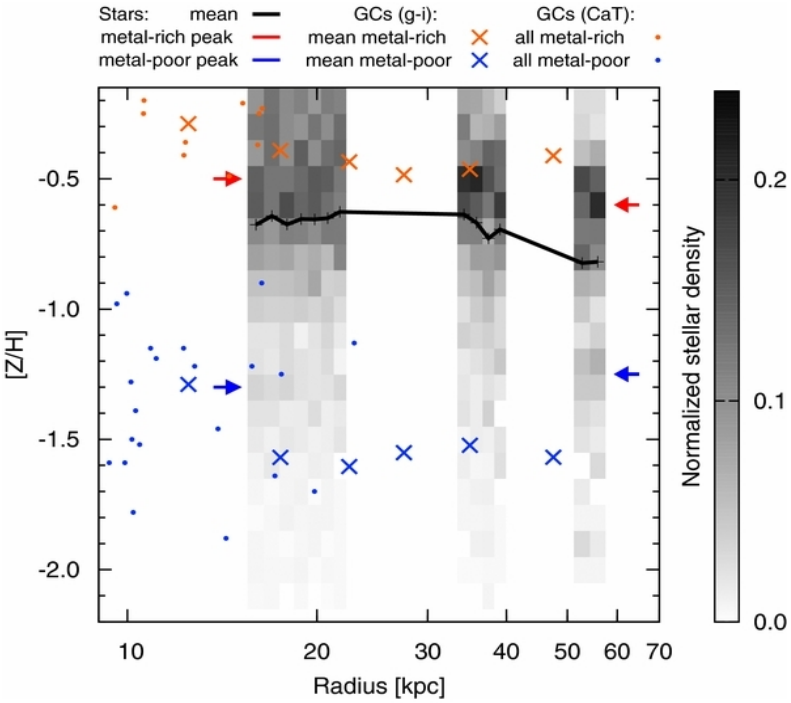


Rejkuba et al. 2014

NGC 3115: tracing the metal-poor halo component



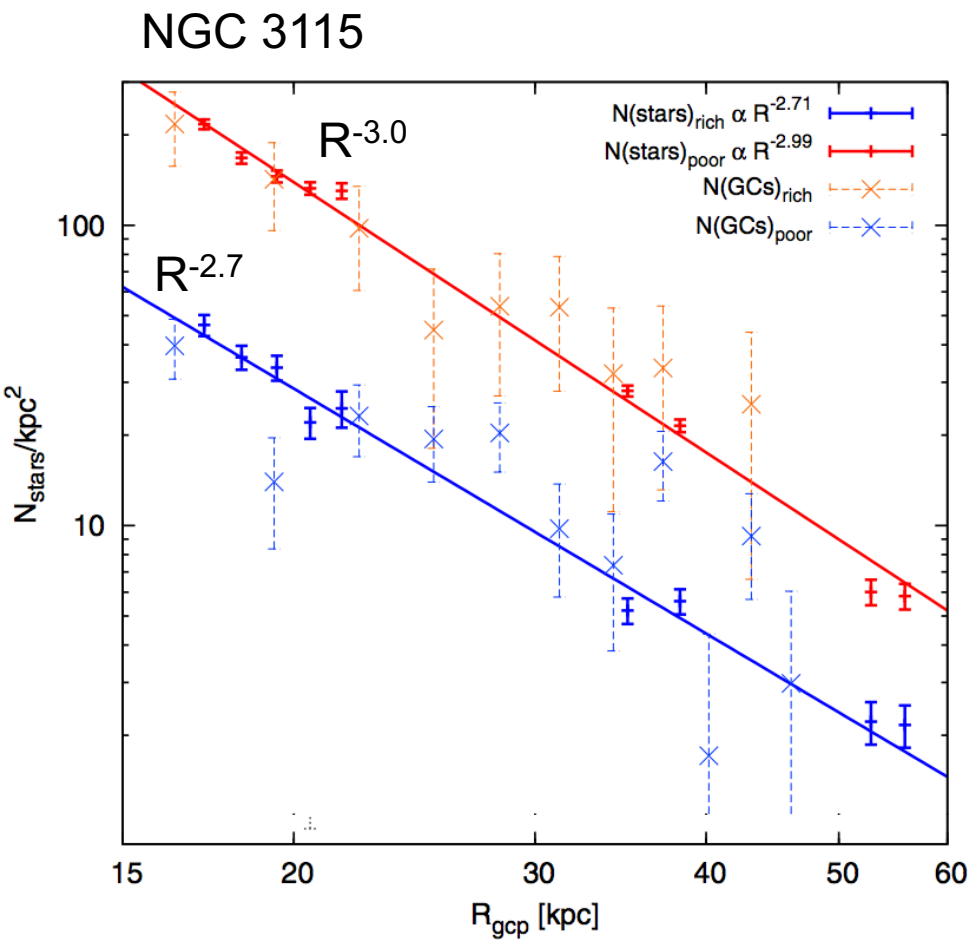




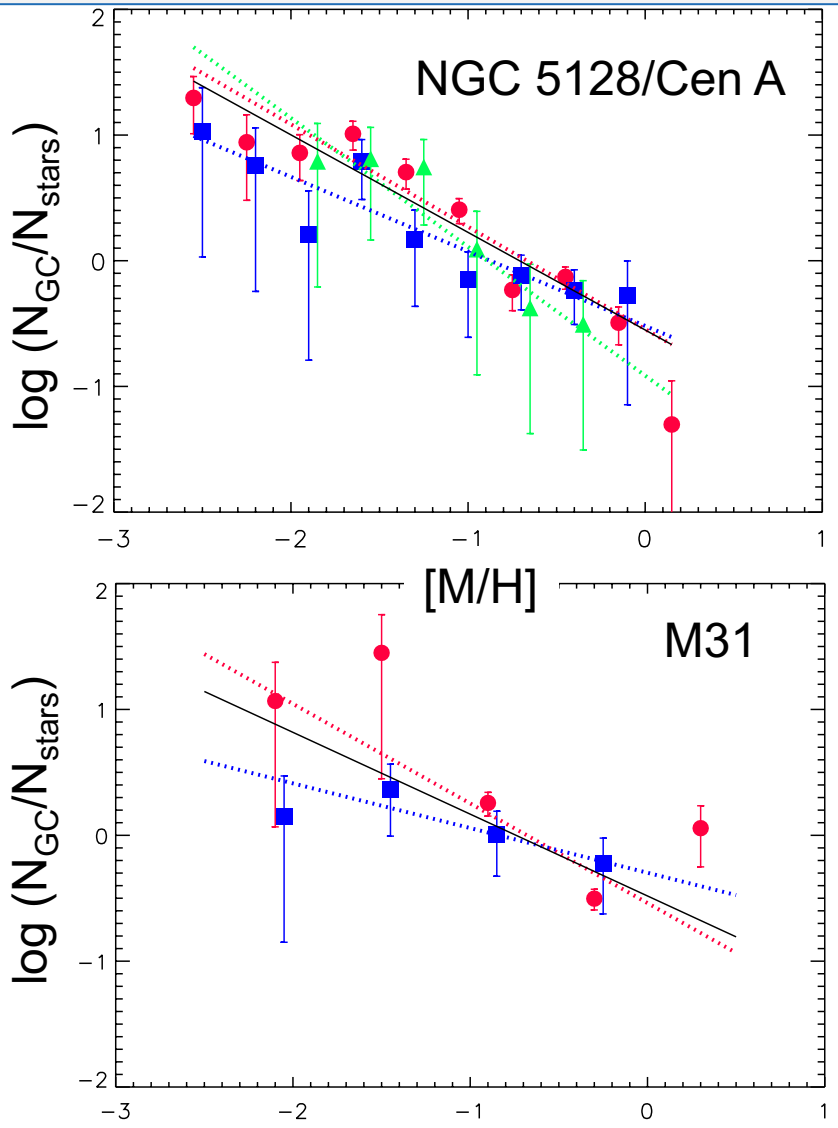
Peacock et al. 2015
NGC 3115: S0, ~10^{11} $M_\odot$

- MDFs over 15–60 kpc (6–23r_e) in the halo
- [M/H] ~ −0.5 @15kpc to [M/H] ~ −0.65 @ 55kpc
- [M/H]<-0.95 dex fraction: 17% → 28% @ 55kpc
- metal-poor (-1.3 dex) component would dominate only beyond ~200kpc

Globular Clusters trace the halo



Peacock et al. 2015



Lamers et al. 2017

Few take home messages

- Resolved stellar halos
  - (Most) large galaxies have extended LSB halos
  - Metal-poor [M/H] ~-1.3 dex component – shallower density profile than metal-rich → may dominate only at very large distances
  - Halo shape and size?
- Globular Clusters
  - Blue GCs trace the metal-poor stellar halo component
  - Blue GCs – more extended/shallower slope
  - Metallicity dependent ratio of GCs/stars

Resolved stellar halo studies in large late and early type galaxies

- M31: PAndAS and SPLASH surveys, Tanaka et al. 2010
- M81: Barker et al. 2009, Okamoto et al. 2015, GHOSTS
- NGC 2403: Barker et al. 2012, GHOSTS
- NGC 891: Rejkuba et al. 2009, Mouhcine et al. 2010, GHOSTS
- NGC 55: Tanaka et al. 2011
- NGC 253: Bailin et al. 2011, Greggio et al. 2014, GHOSTS
- GHOSTS (6 disk galaxies within 17 Mpc): Monachesi et al. 2016
- NGC 4631: Tanaka et al. 2017

- NGC 5128 (Cen A): Soria+96; Harris+99; Harris & Harris 00,02; Rejkuba+03,05,11,14; Crnojević+13,16; Bird+14
- NGC 3379 (M105): Sakai+97; Gregg+04; Harris+07b, Lee & Jang 2016
- NGC 3115: Peacock+15
- NGC 3377: Harris+07a
- NGC 4486 (M87): Bird+10, Lee & Jang 2017

WINGS: WFIRST Infrared Nearby Galaxy Survey

WFIRST
WIDE-FIELD INFRARED SURVEY TELESCOPE
ASTROPHYSICS • DARK ENERGY • EXOPLANETS

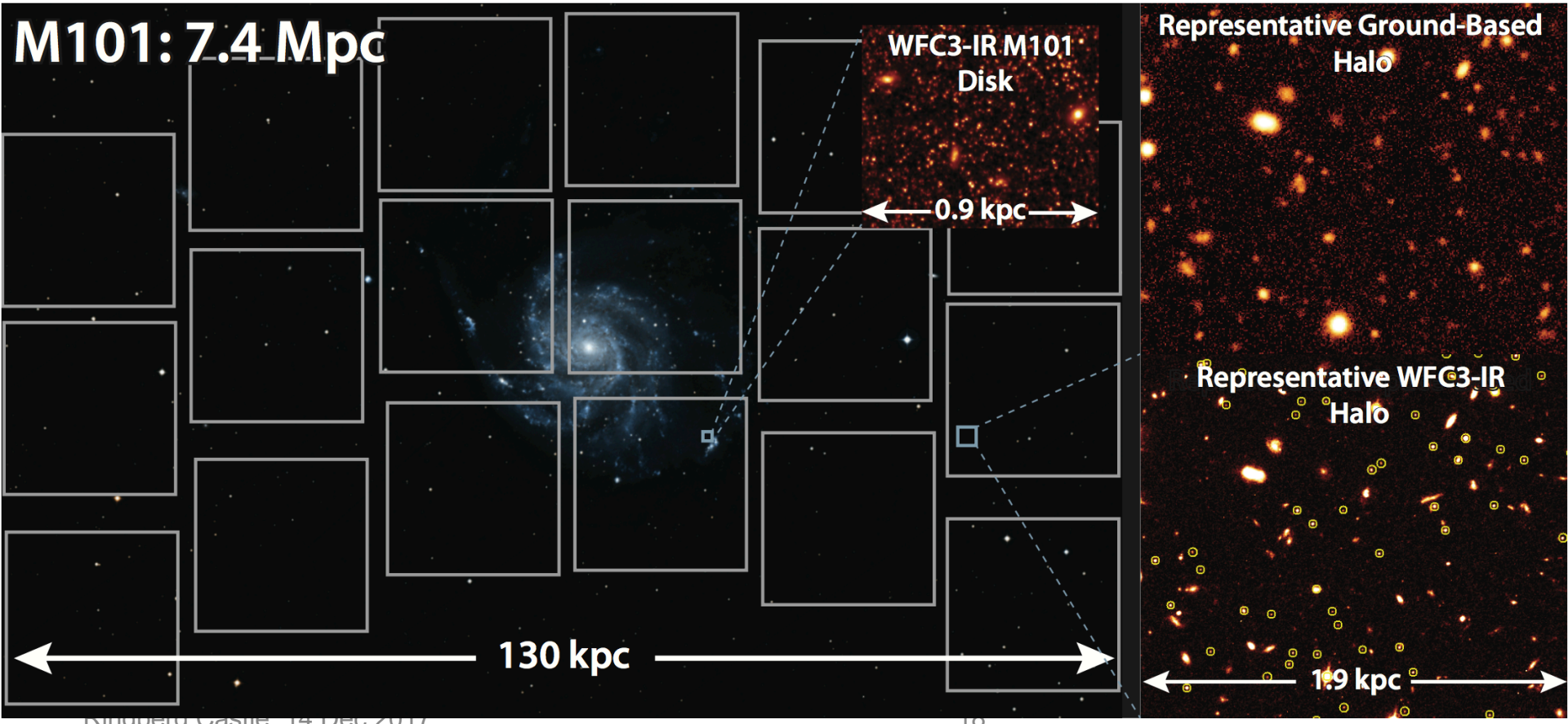
High Level Goals:

- Design a WFIRST Nearby Galaxy survey to maximize its scientific return
  - 200 galaxies within 10-15 Mpc
- How do WFIRST requirements (e.g. filters, photometric stability/uniformity, etc.) flow down to the science results achievable in the Local Universe?
- Simulate realistic galaxies, halos and satellite systems
- Develop a photometric pipeline for measuring crowded field point source photometry and astrometry from WFIRST data

PI: Ben Williams
Co-PIs: J. Anderson, E. Bell, M. Boyer, J. Bullock, J. Dalcanton, L. Dolphin, L. Girardi, K. Gordon, K. Johnston, D. Sand, A. Seth, M. Walker
Postdoc: Rubab Khan
Collaborators:
A. Bolatto, J. Chaname, D. Crnojević, P. Guhathakurtha, L. Johnson, D. Lang, N. Martin, A. McConnachie, M. Meixner, A. Monachesi, J. Peek, J. Peñarrubia, A. Price-Whelan, M. Rejkuba, J. Roman-Duval, P. Rosenfield, L. Sales, R. Sanderson, K. Sandstrom, J. Strader, C. Wheeler, B. Willman

WFIRST
WIDE-FIELD INFRARED SURVEY TELESCOPE
ASTROPHYSICS • DARK ENERGY • EXOPLANETS

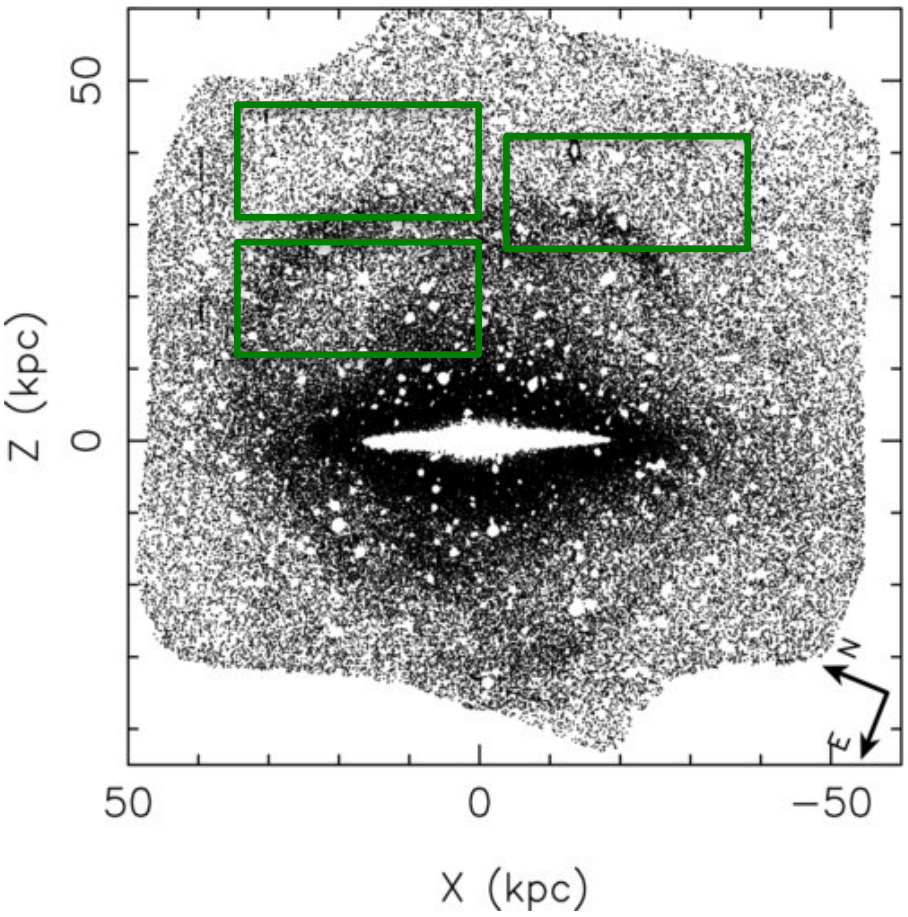
Filters: Z087, Y106, J129, H158
HST like resolution
Launch in ~2025

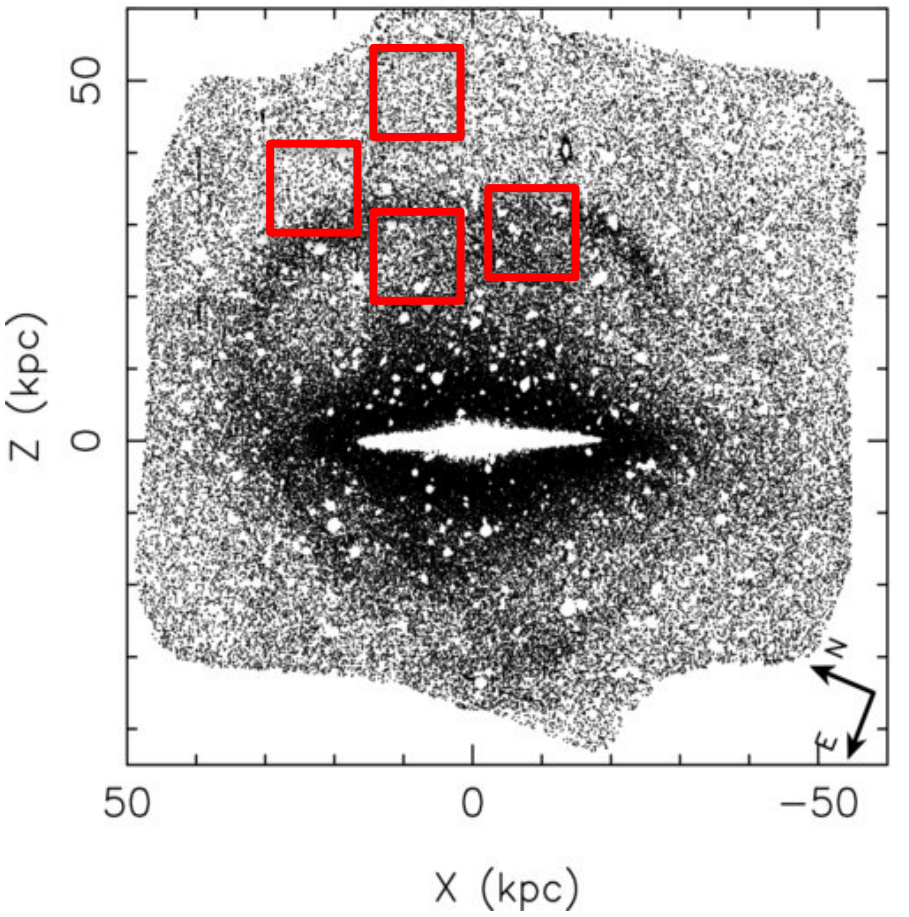


JWST & ELT(s)

JWST: at 25 Mpc (DM = 32)
NIRcam field ~2x(16 x 16) kpc^2

E-ELT: at 50 Mpc (DM = 33.5)
MICADO field ~13 x 13 kpc^2





NGC 891 (Mouhcine+2010) shifted to 25 & 50 Mpc