



*Satellites and Streams in Santiago*  
*ESO Chile, 13-17 April, 2015*

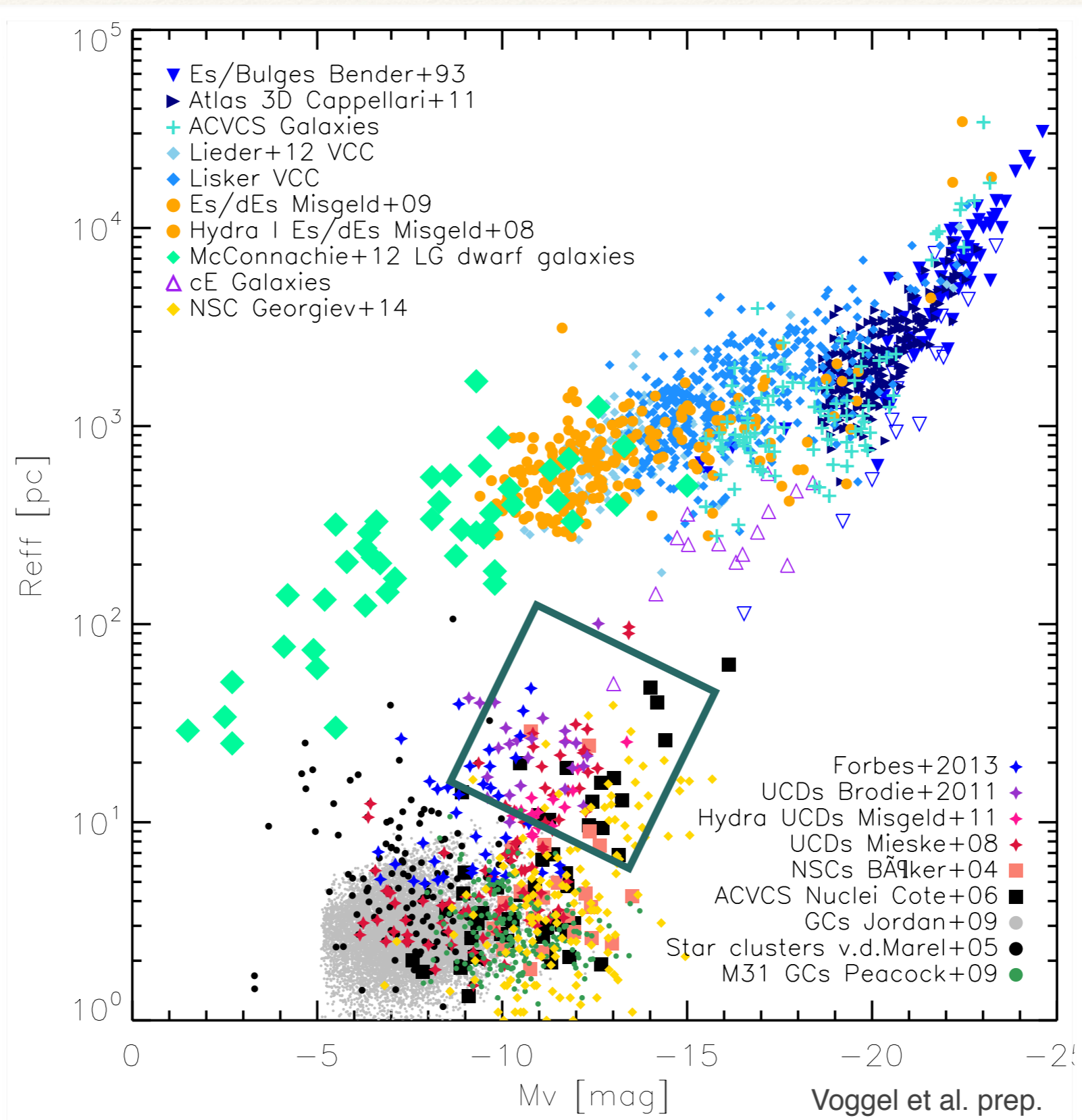
# The origins of the Ultra Compact dwarfs in the Halo of NGC1399

Karina Voggel  
PhD Student @ESO Garching  
Michael Hilker, Tom Richtler

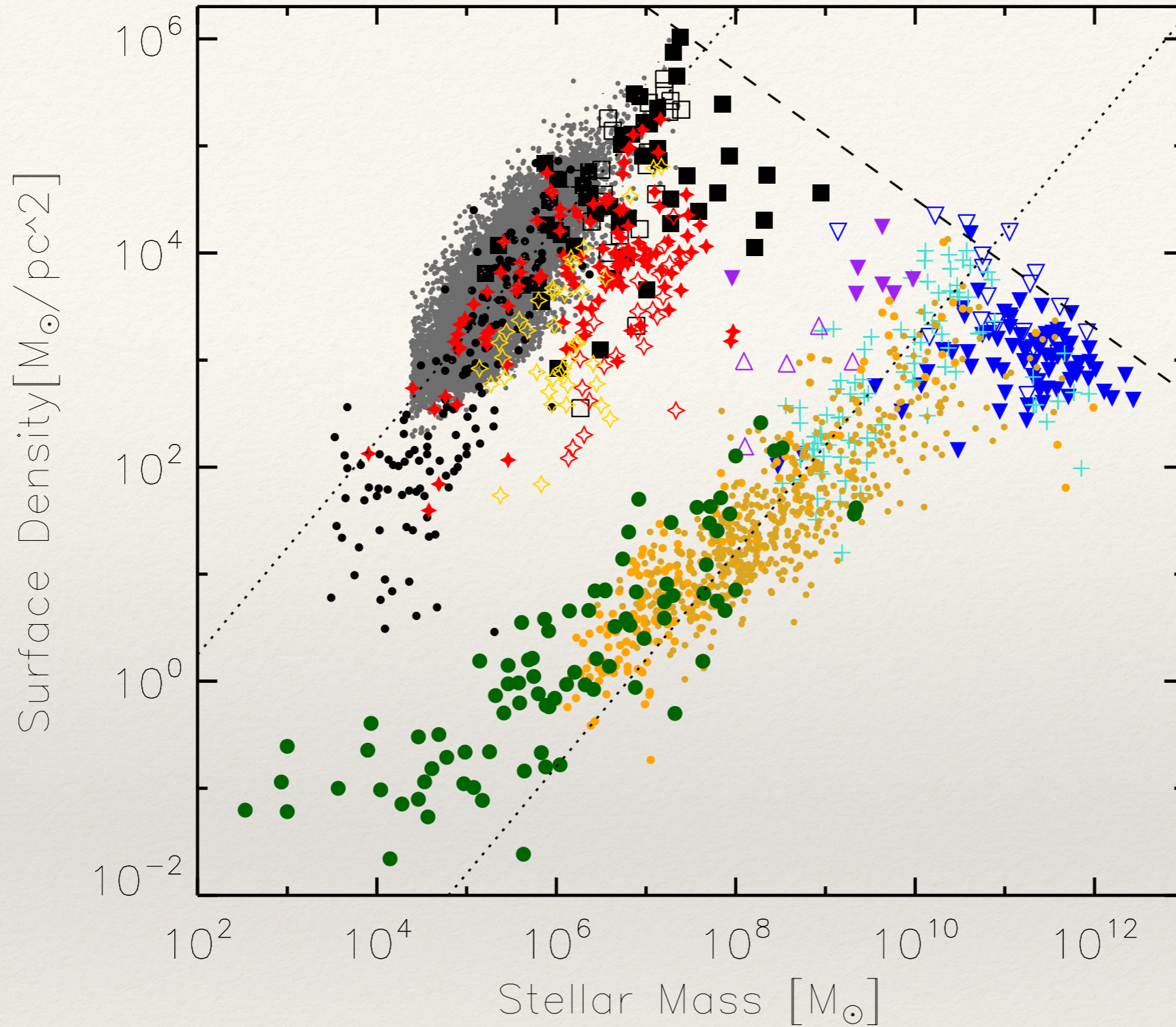




# What are UCDs?







Surface density of stellar systems



---

# What are the origins of UCDs?

---

Two possible formation channels:

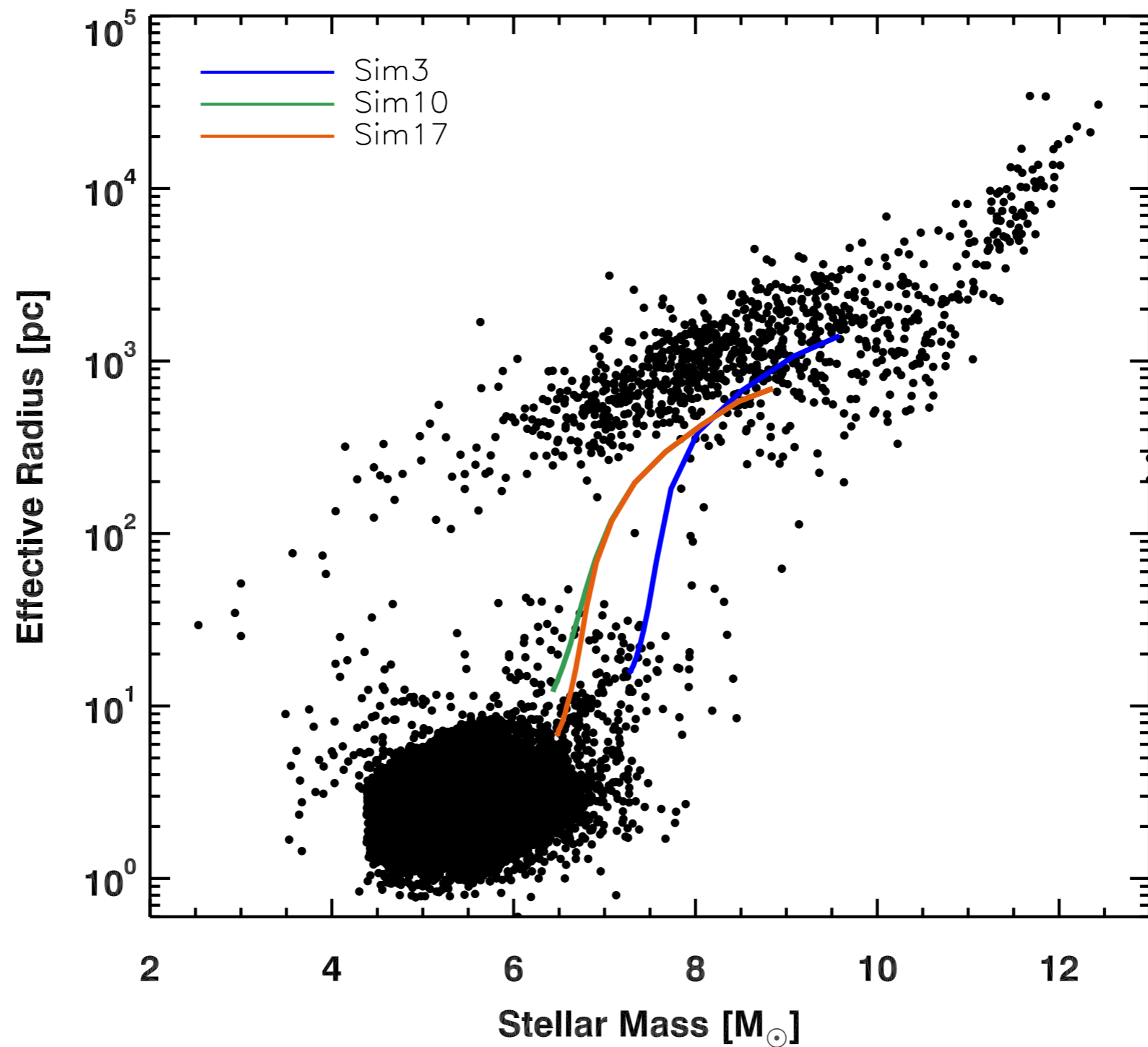
1. The high mass end of the GC luminosity function
2. The stripped nuclei of dwarf Elliptical galaxies

-> Goal: constrain the contribution of each formation channel to the final luminosity function of UCDs with new strategies

-> Find direct evidence for the stripping channel



# The Stripping Scenario



Voggel et al. in prep. (Simulation tracks based on Pfeffer&Baumgardt (2013))



---

# Constraining Formation Channels

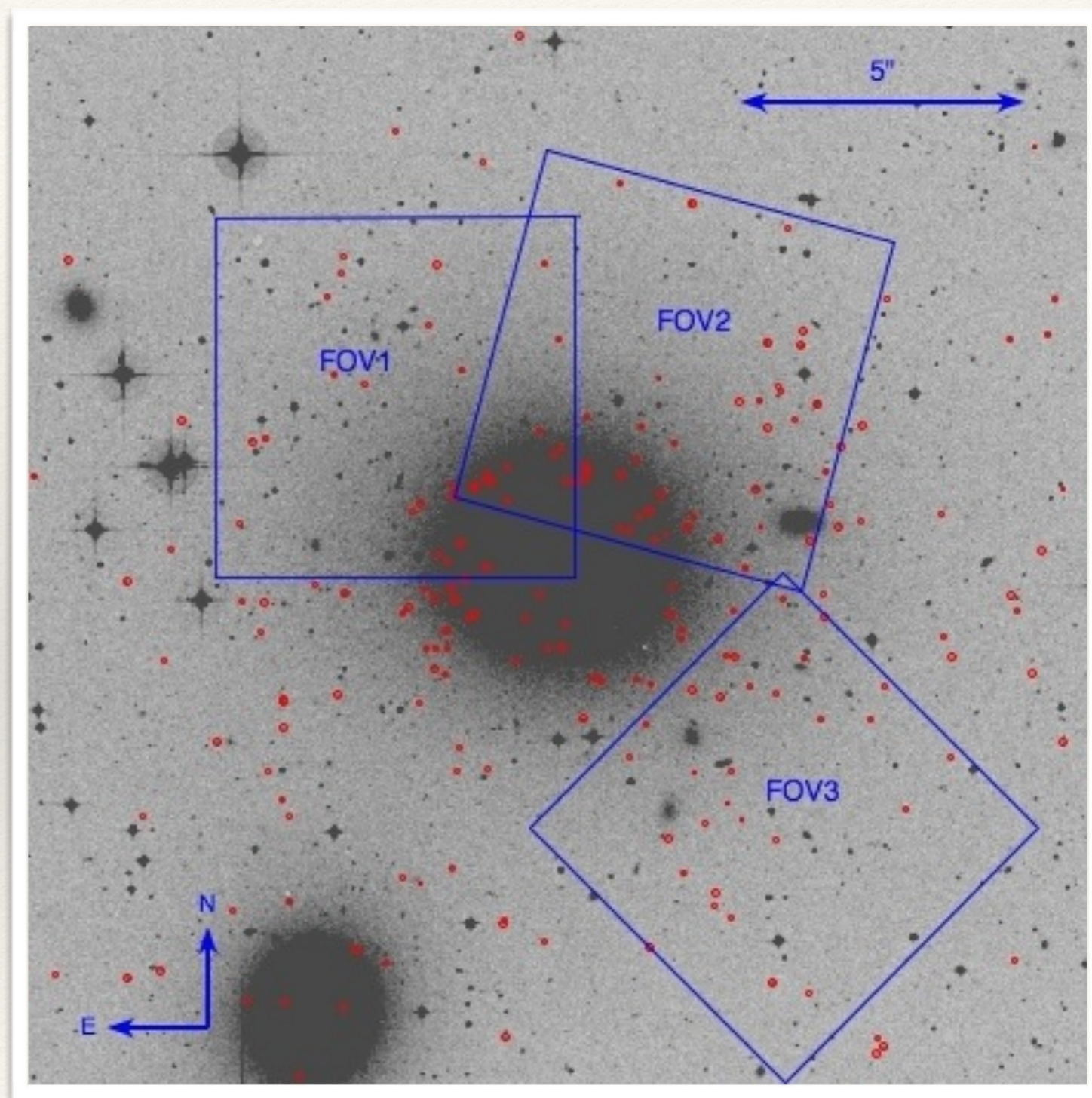
---

- ❖ Comparing the properties of large UCD sample to GCs/nuclei:
  - ❖ Spatial Distribution
  - ❖ Size-magnitude relation
  - ❖ metallicity distribution
- ❖ Single UCDs
  - ❖ color and magnitudes
  - ❖ velocity dispersion to constrain dynamical mass
  - ❖ surface brightness profiles / tidal features
  - ❖ resolving the stellar populations



# Spatial Distribution of UCDs and GCs

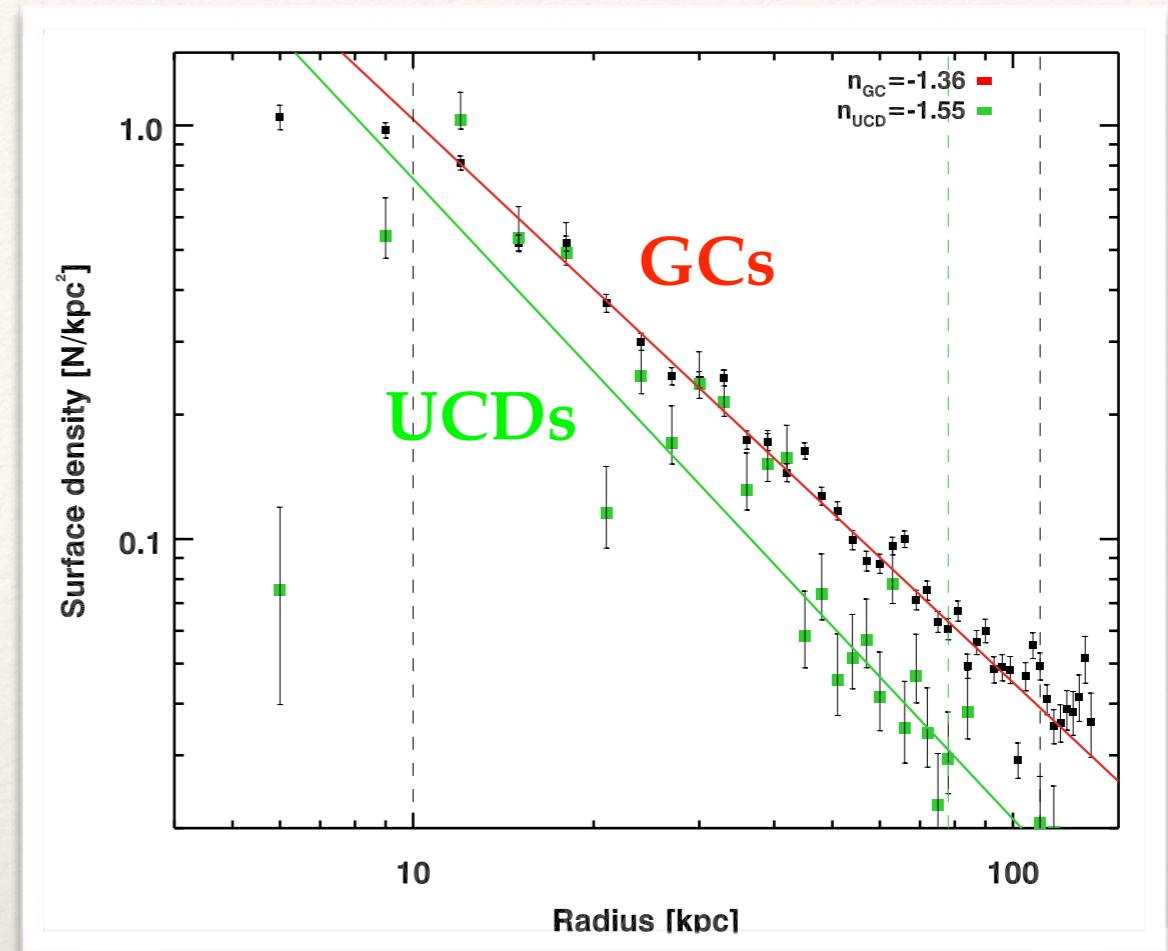
- ❖ Spatial distribution of UCDs (red) around NGC1399, the central Fornax galaxy
- ❖ All UCDs are confirmed members of the Fornax cluster
- ❖ Wide field sample of GCs and UCDs (Dirsch et al. 2003)
- ❖ Three smaller FORS2 fields with photometry on 109 UCDs in good 0.6'' seeing conditions





# Spatial distribution of GCs around NGC1399

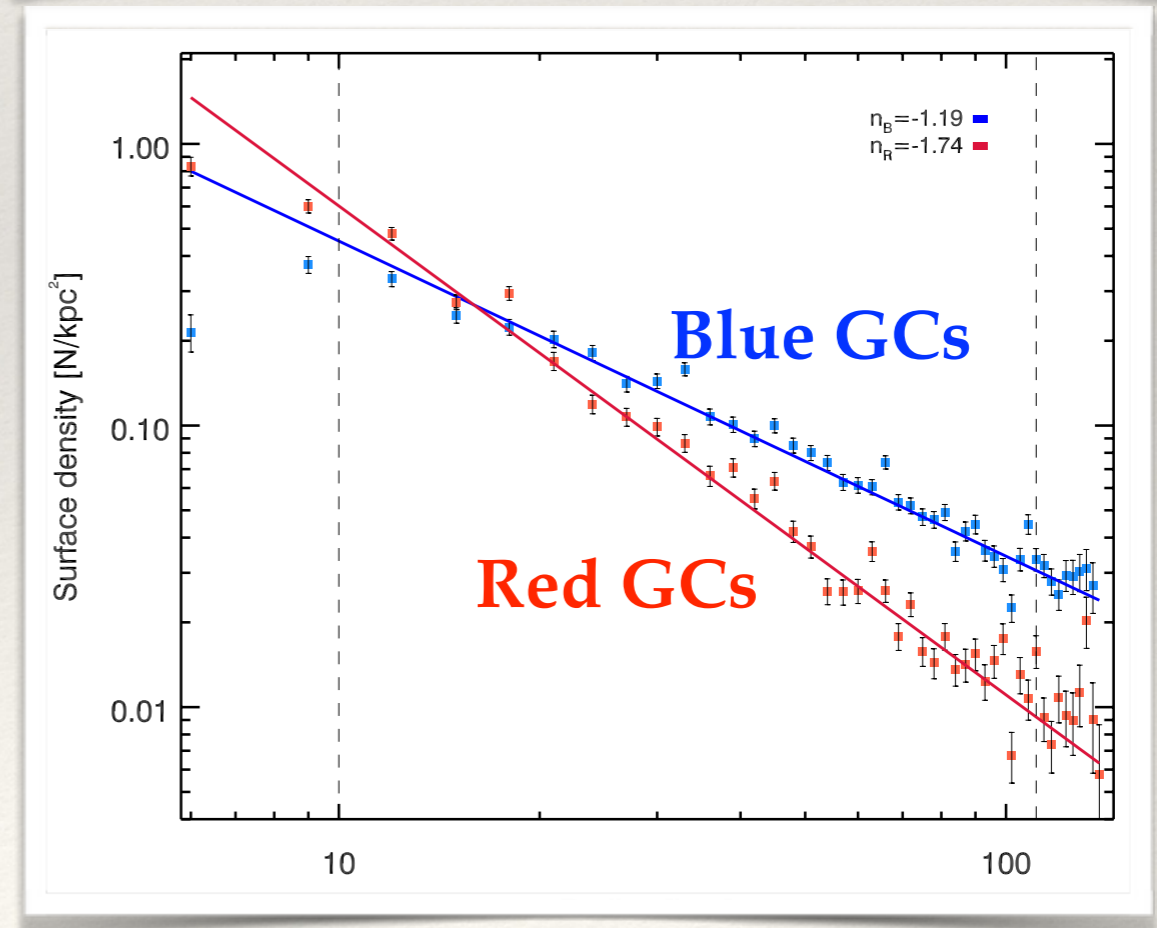
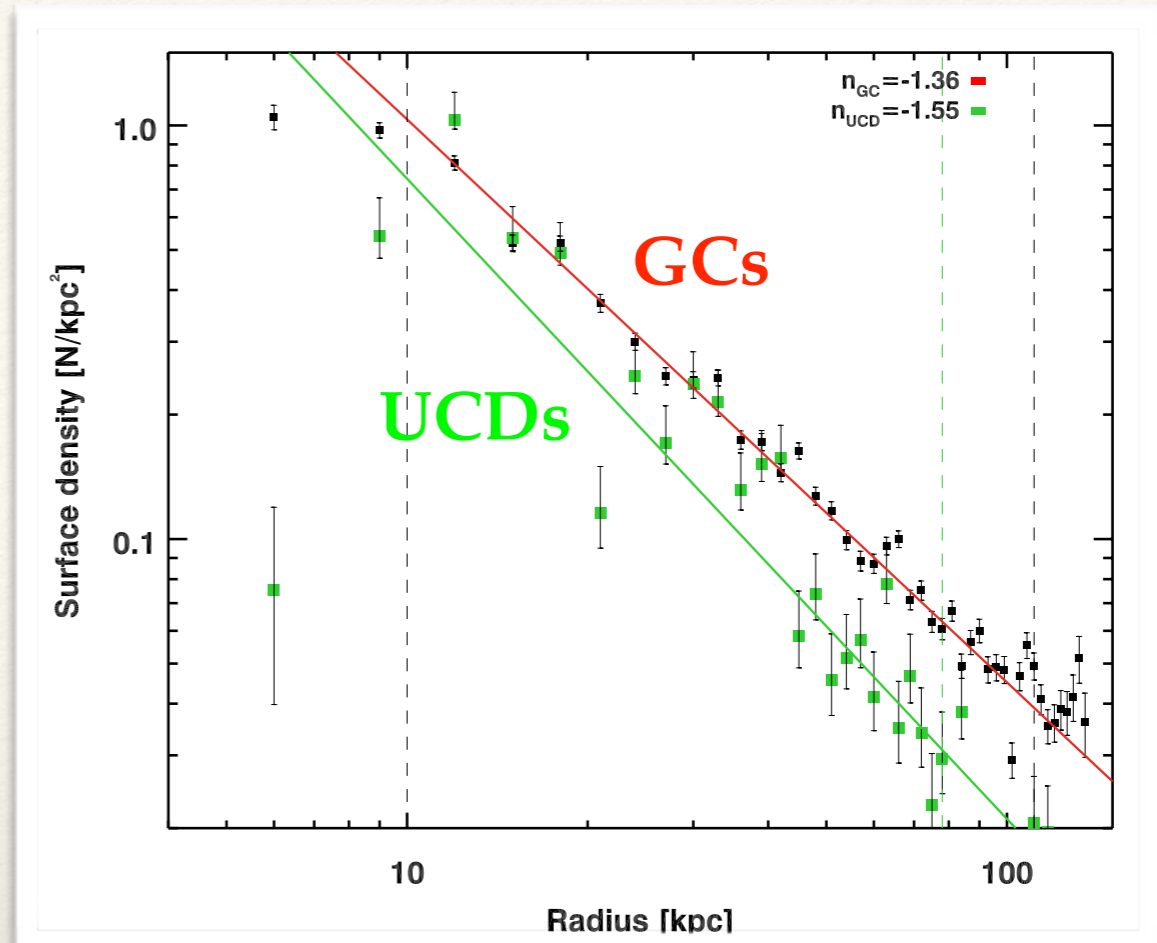
- ❖ Projected surface density profiles around NGC1399
- ❖ Top panel: GC sample (red line) and UCD sample (green)
- ❖ Solid lines: Fitted power law to the surface density





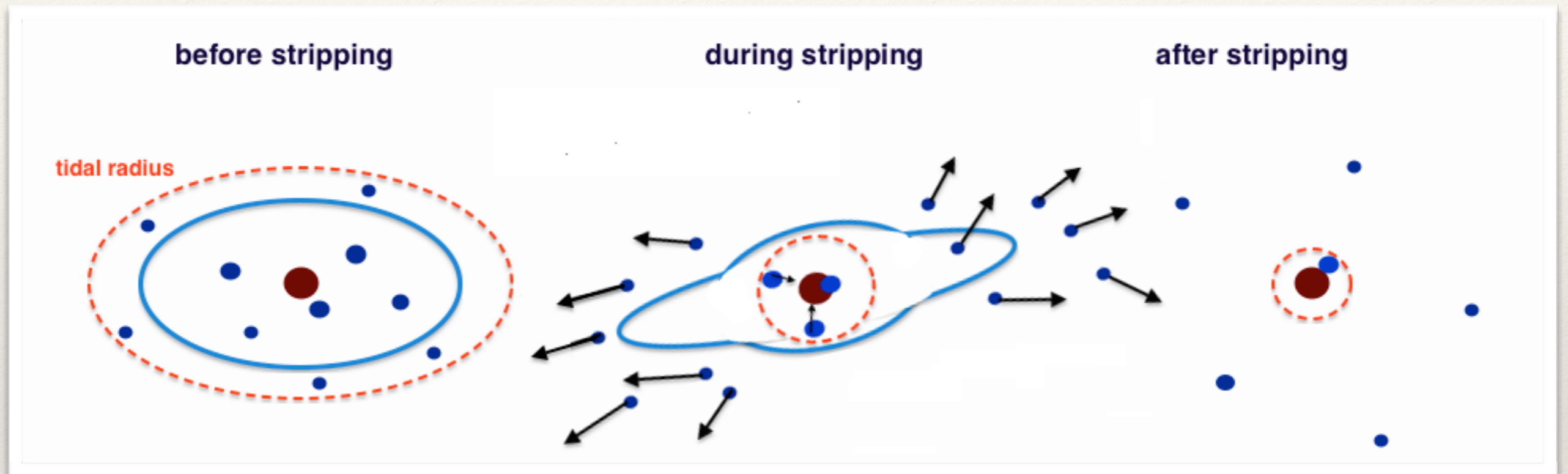
# Spatial distribution of GCs around NGC1399

- ❖ Projected surface density profiles around NGC1399
- ❖ Top panel: GC sample (red line) and UCD sample (green)
- ❖ Solid lines: Fitted power law to the surface density
- ❖ Bottom panel: for the blue and red GC population separately
- ❖ Red population steeper and more centrally concentrated than the blue component





# What happens to the GCs of a dE during stripping?



**dwarf Elliptical**



**UCD**

GC system of dEs: Lotz et al. (2001, 2004)

Dynamical Friction: Arca-Sedda & Capuzzo-Dolcetta (2014), Capuzzo-Dolcetta, (1993)

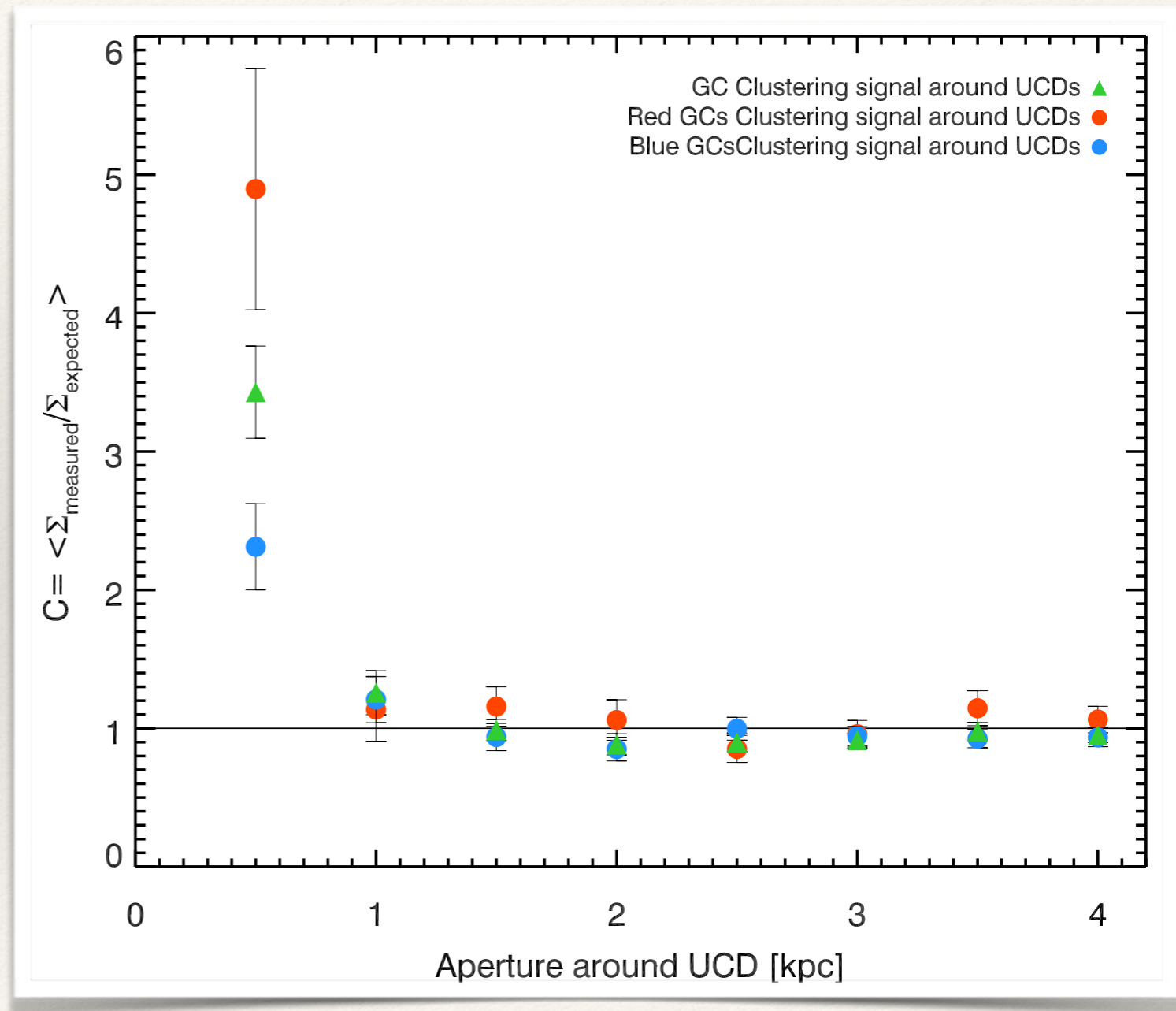


# Spatial Clustering of GCs around UCDs

❖ Is the surface density of GCs around UCDs systematically higher than what is expected from the main distribution of the GCs in the halo?

-> We find a systematic *average* overdensity within 500pc for all GCs and the colour separated samples

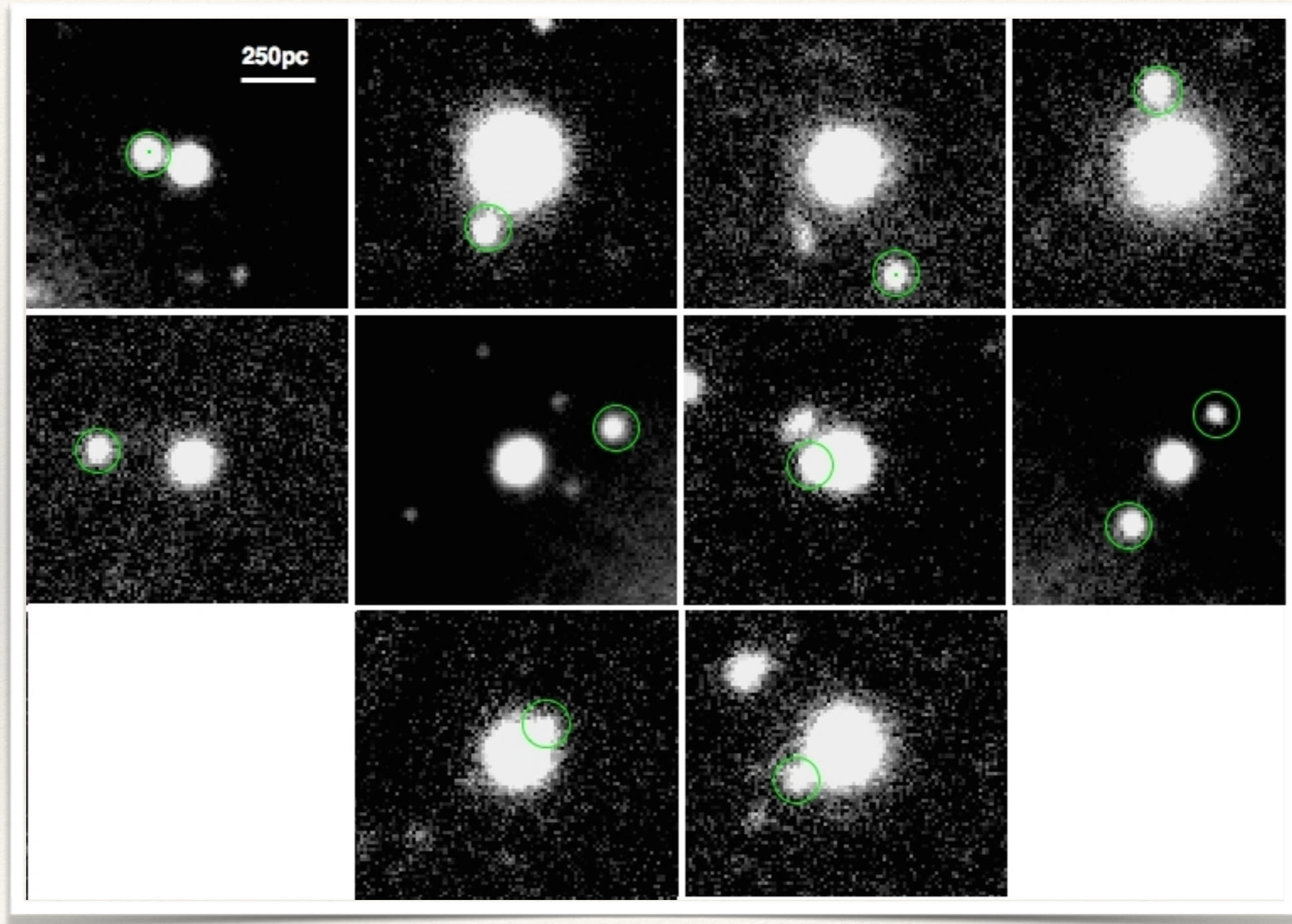
-> Red GCs are correlated stronger with UCDs than blue ones





# Do UCDs have GC companions?

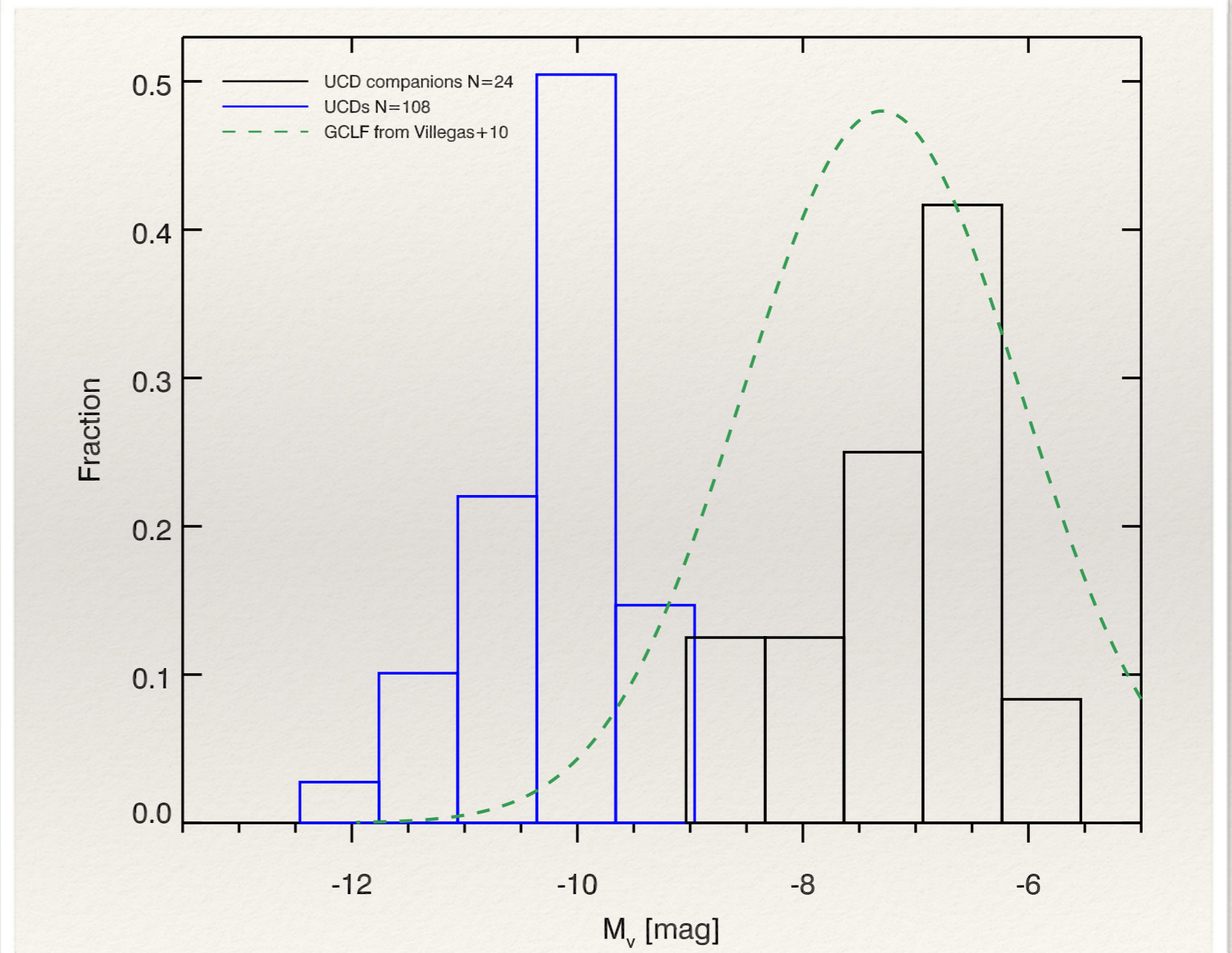
- ❖ Close up images of UCD companion sources within  $r < 200 \text{ pc}$
- ❖ Some blend with the light profile of UCD
- ❖ Dwarf galaxy with pericenter  $R = 20 \text{ kpc}$  is  $\sim 250 \text{ pc}$  for a  $10^7 \text{ UCD}$





# Luminosity Function of UCDs and GCs

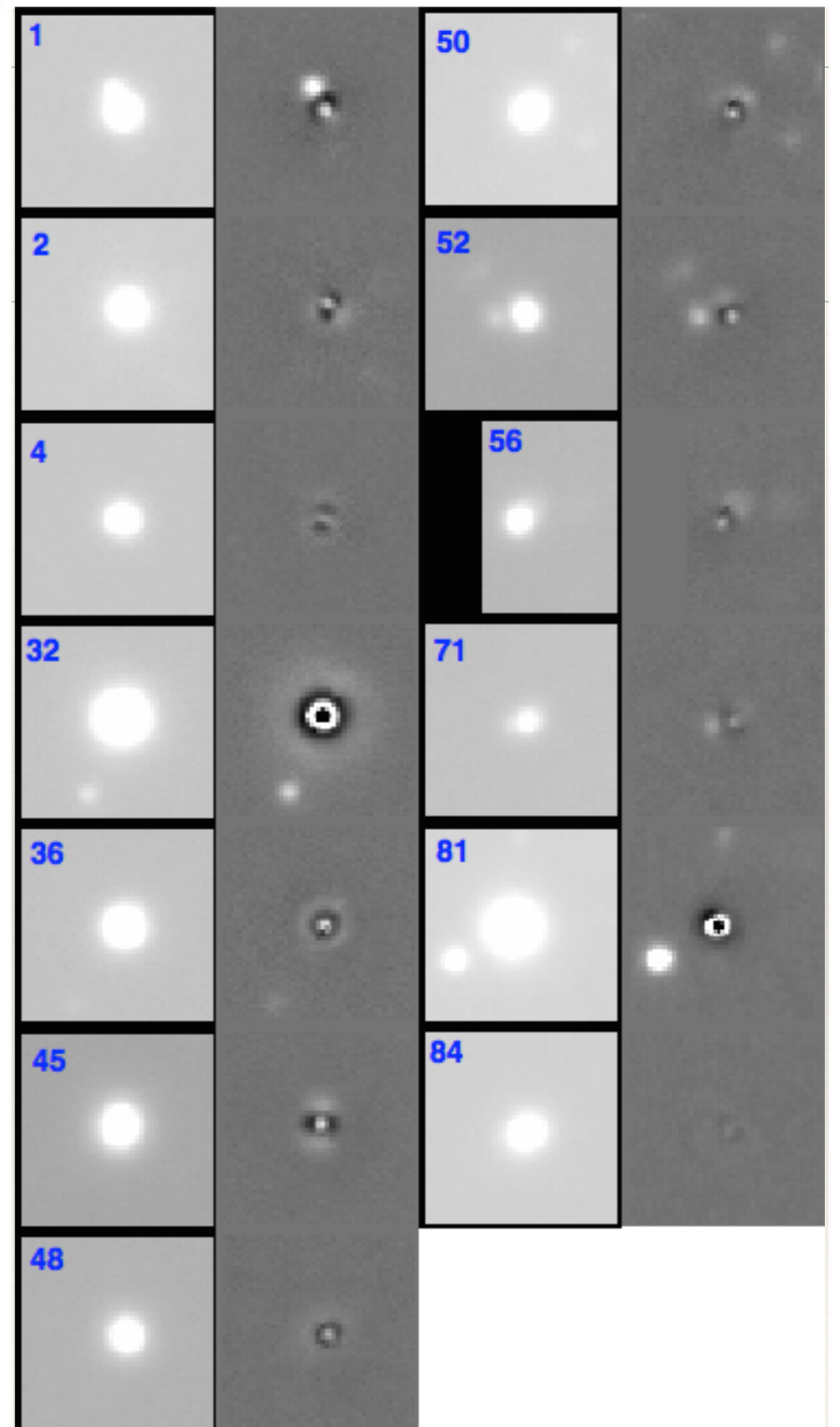
- ❖ Luminosity Function of UCDs in the FORS fields (blue)
- ❖ GCLF of NGC1399 from Villegas et al. 2010 in dashed green
- ❖ For the 24 objects that showed very nearby point sources ( $r < 200\text{pc}$ ) we measured their magnitude after subtracting the UCD model
- ❖ Histogram of companion sources to the UCDs in black



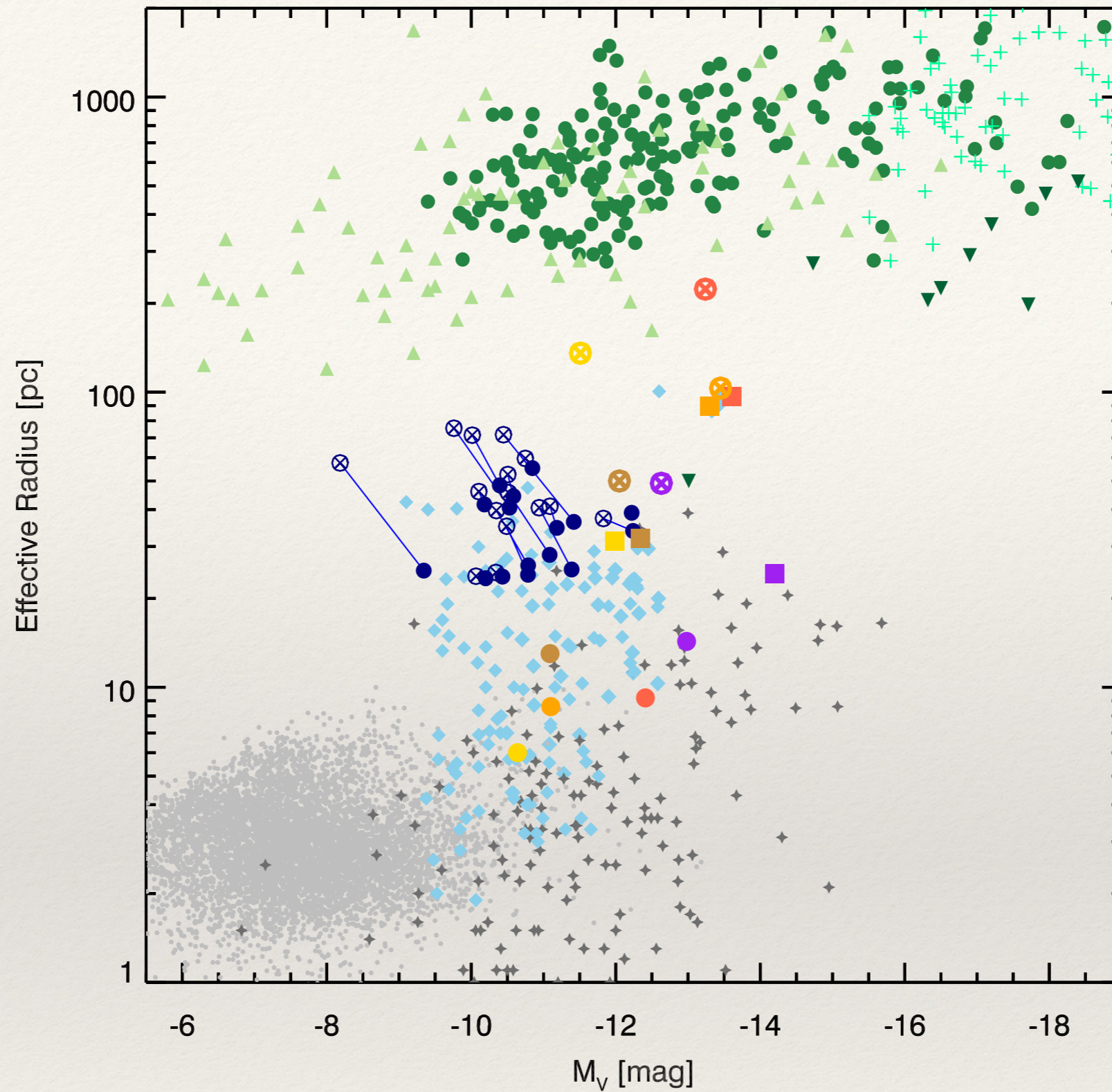


# Surface Brightness Profiles of UCDs

- ❖ Studied detailed structural composition of 108 UCDs in the halo of NGC 1399 by fitting several profiles with GALFIT
- ❖ 16 UCDs (14.8%) are extended above the resolution limit of  $\sim 23\text{pc}$  when fitted in a single Sersic fit
- ❖ Fitted a core+envelope model with fixed 10pc King core and a Sersic envelope

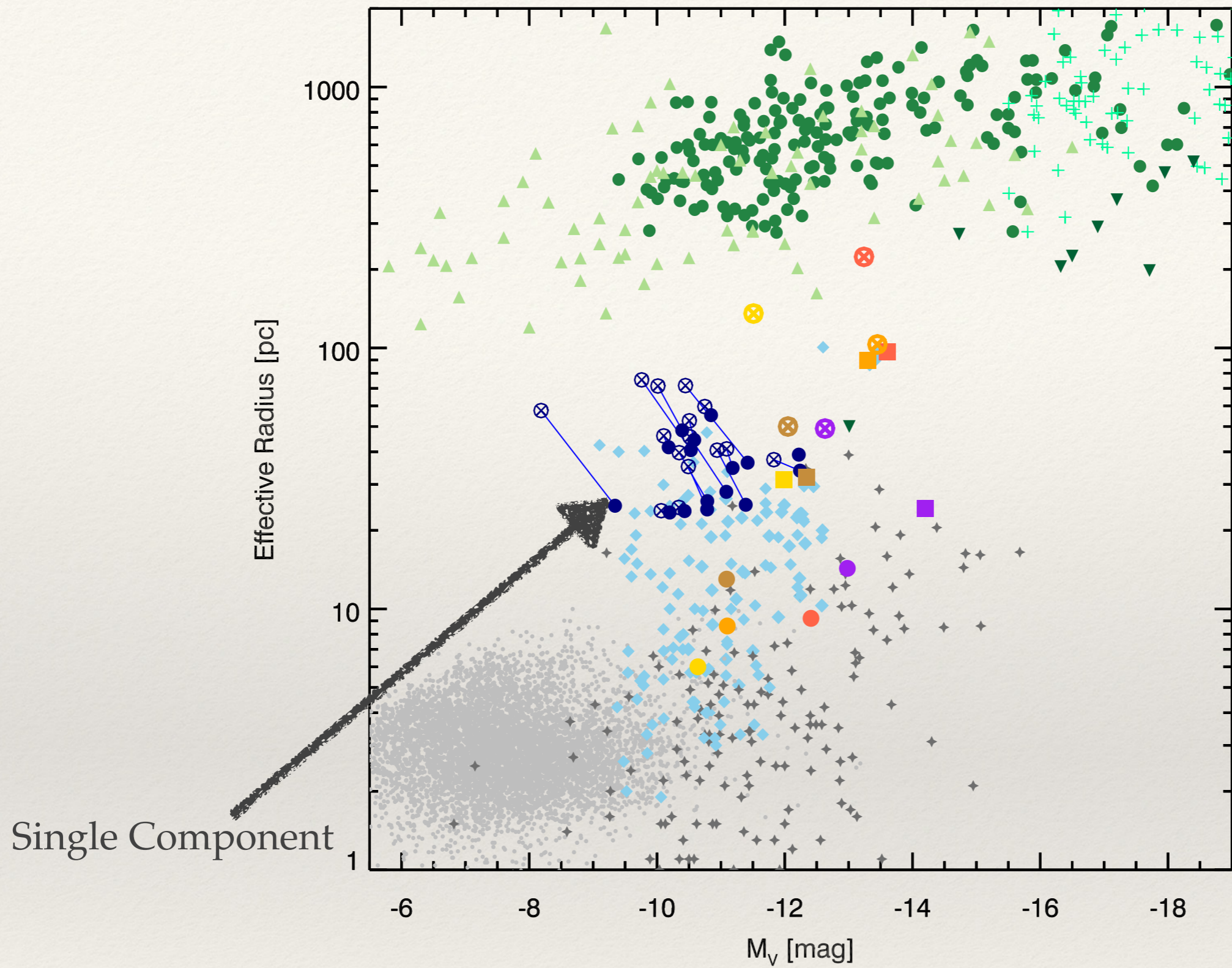






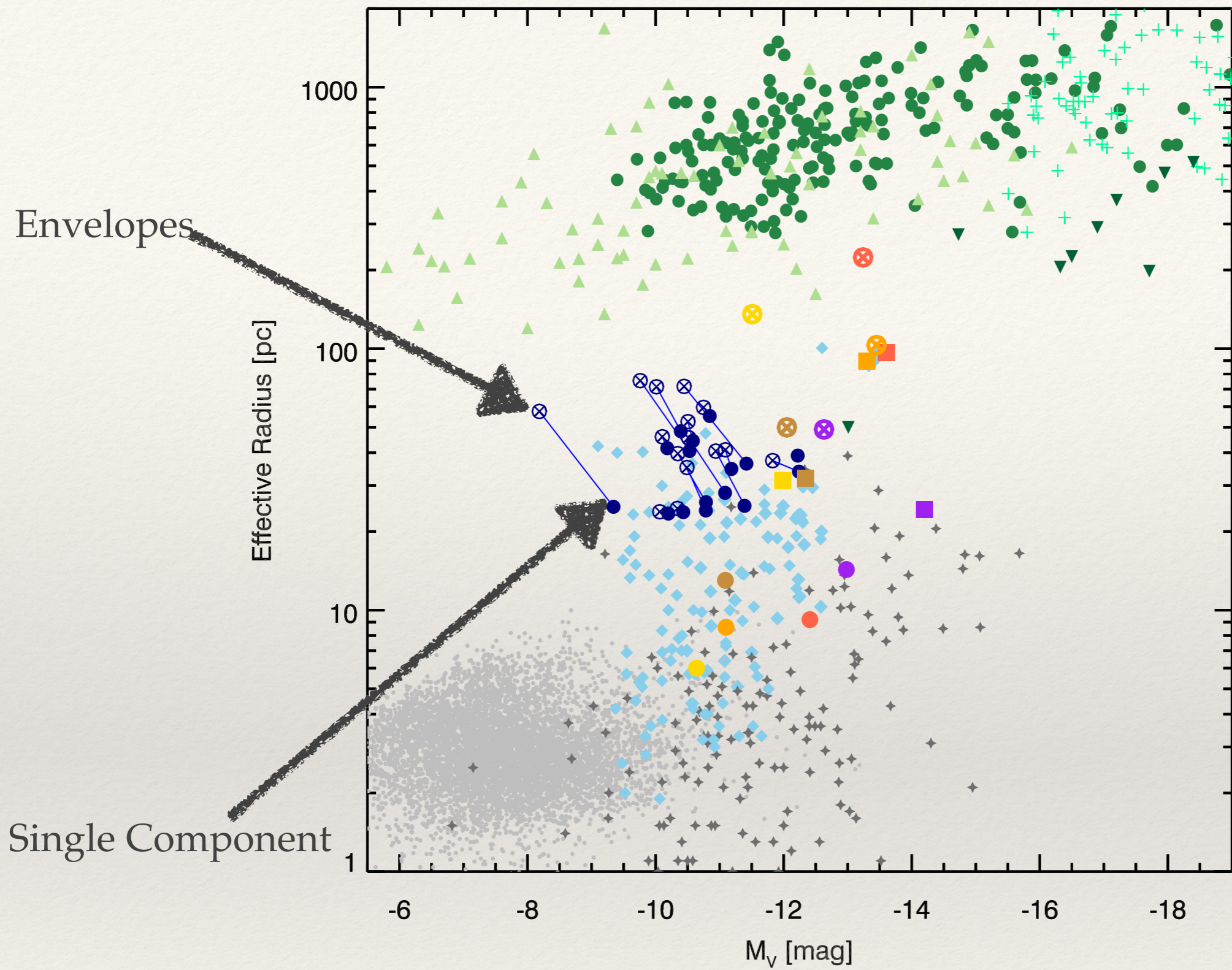
Filling the Magnitude Size Plane





Filling the Magnitude Size Plane



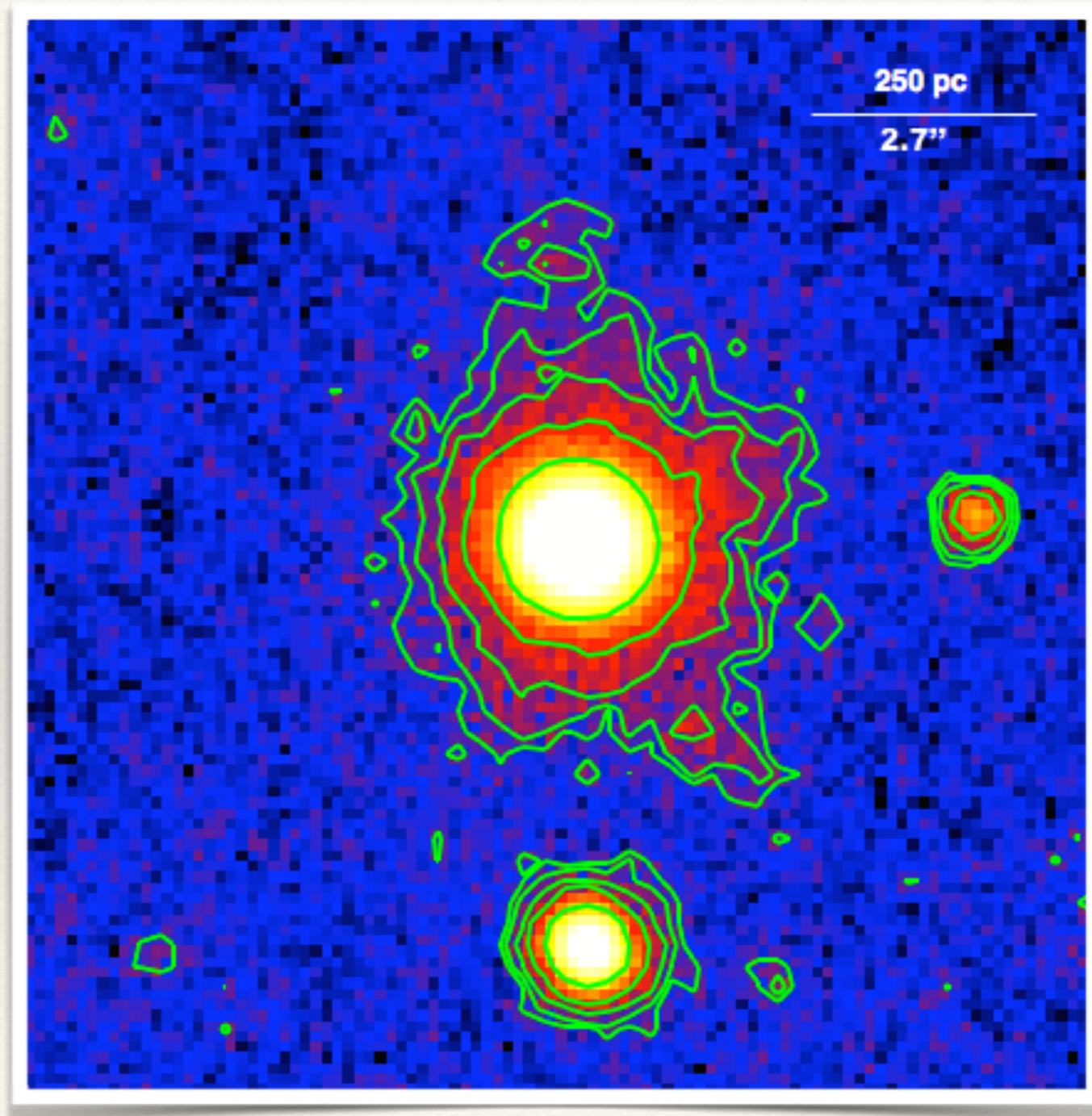


Filling the Magnitude Size Plane



# Tidal tails around UCDs

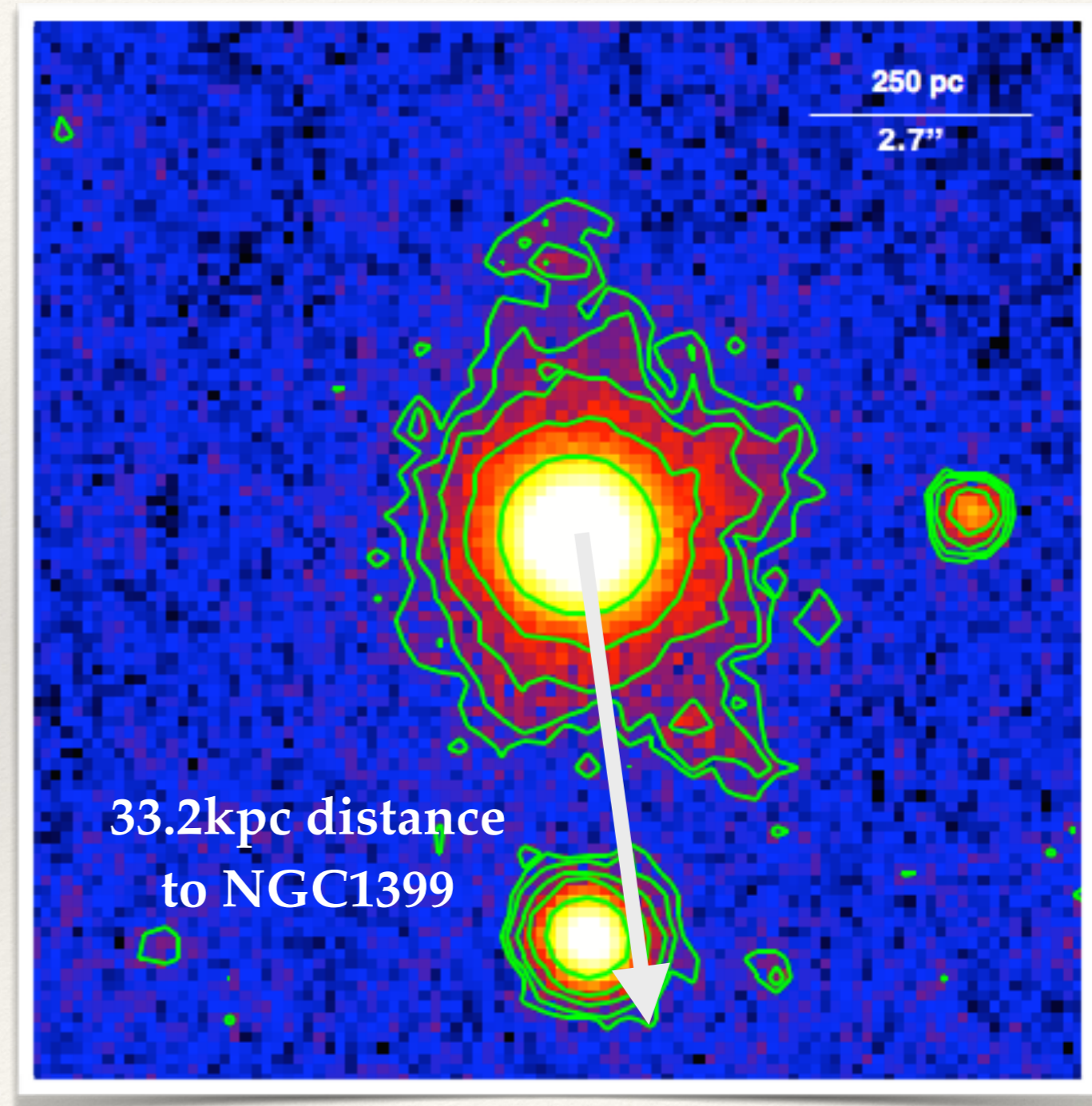
- ❖ Two large tidal tails detected with  $\sim 350$  pc radial extension found around UCD in Fornax
  - ❖ high relative radial velocity  $v=1074$  km/s relative to NGC1399 with  $v=1425$  km/s
  - ❖ Tidal radius  $\sim 280$  pc at the distance to NGC1399
- > Direct observation of the transformation of a dE galaxy into a UCD?





# Tidal tails around UCDs

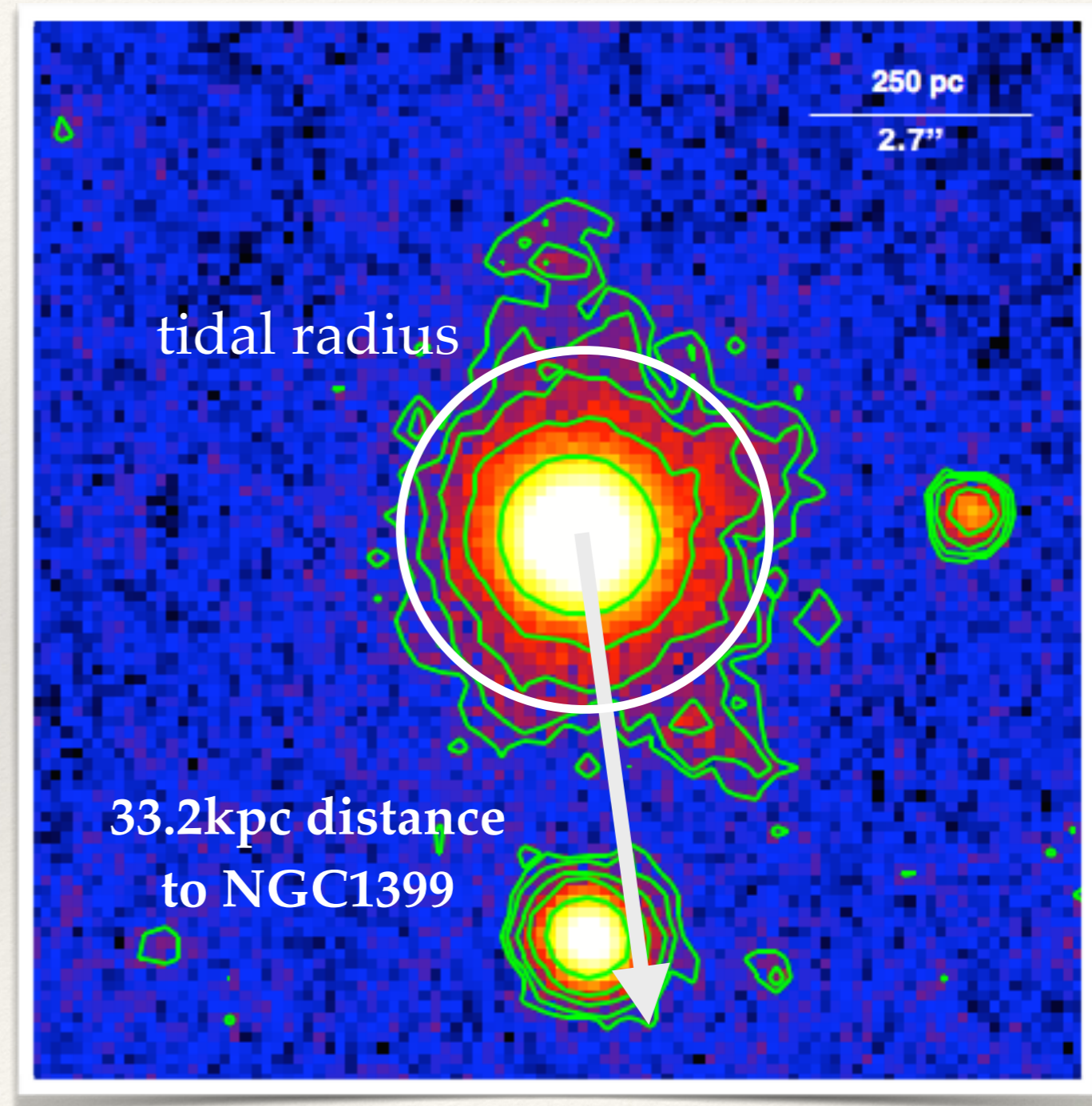
- ❖ Two large tidal tails detected with  $\sim 350$ pc radial extension found around UCD in Fornax
  - ❖ high relative radial velocity  $v=1074$ km/s relative to NGC1399 with  $v=1425$ km/s
  - ❖ Tidal radius  $\sim 280$ pc at the distance to NGC1399
- > Direct observation of the transformation of a dE galaxy into a UCD?





# Tidal tails around UCDs

- ❖ Two large tidal tails detected with  $\sim 350\text{pc}$  radial extension found around UCD in Fornax
  - ❖ high relative radial velocity  $v=1074\text{km/s}$  relative to NGC1399 with  $v=1425\text{km/s}$
  - ❖ Tidal radius  $\sim 280\text{pc}$  at the distance to NGC1399
- > Direct observation of the transformation of a dE galaxy into a UCD?





---

# Summary

---

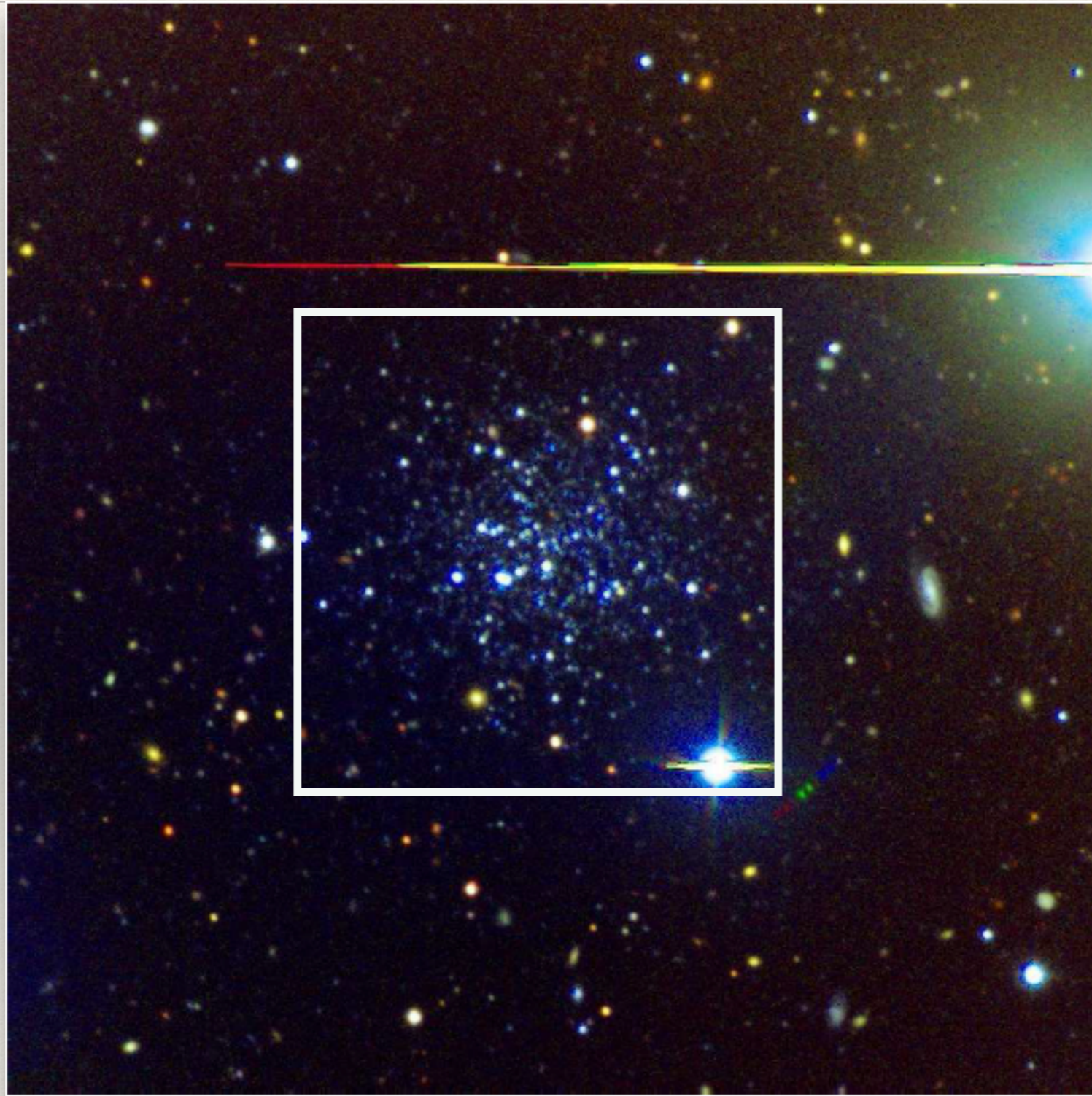
- ❖ GCs are significantly more common at 500pc around UCDs compared with what is expected from the global distribution -> **UCDs and GCs are spatially correlated**
- ❖ Large UCDs well fitted with Sersic profiles. When decomposing into two components the **envelope lies in between galaxy and star cluster branch in size magnitude space.**
- ❖ **First direct evidence for tidal features around UCDs**



---

# Stay tuned for ... Crater!

---





---

# Stay tuned for ... Crater!

---

