Globular Clusters

(& other compact stellar systems)

in the VST FDS and VEGAS surveys

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On behalf of the FSD & VEGAS collaborations

Outline of the presentation

- Why care about Globular Clusters (GCs)
- Strategies & Results
  - VEGAS: NGC253 + NGC3115 techniques for detection & results
  - FDS: detection & results for NGC1399 (MP talk)
- Results

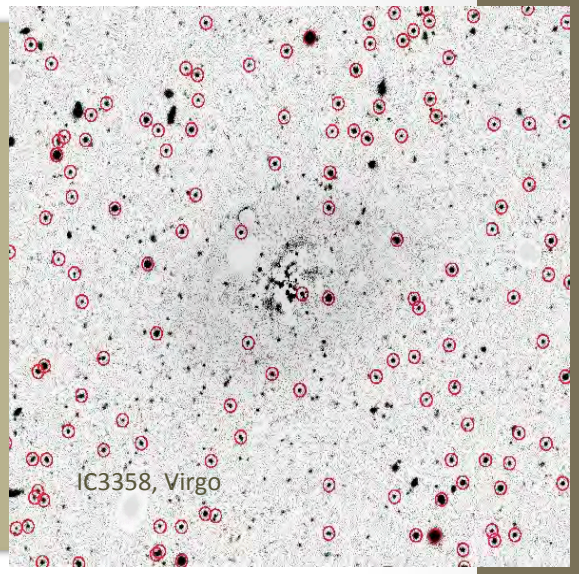
Why care about extra-galactic Globular Clusters?

Observational reasons

- ✓ Bright clumps of stars
- ✓ High contrast with respect to the host galaxy
- ✓ Observed out to very large distances

(HST: Alamo-Martinez+13, z~0.2; Jenssens+17 z~0.3; VLT/MUSE: Vanzella+17, z~3)

- ✓ Hundreds to thousands of GCs in galaxies

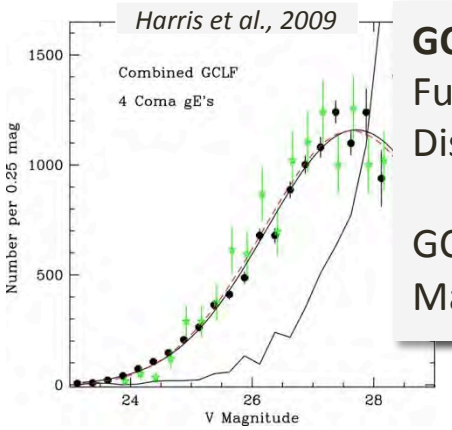


Intrinsic properties

- ✓ Small internal dispersion in Age and Metallicity
- ✓ Old ages (MW; external: Cohen+98, +03, Chies-Santos+11)
- ✓ Fossil tracer of the host environment

Many useful characteristics…

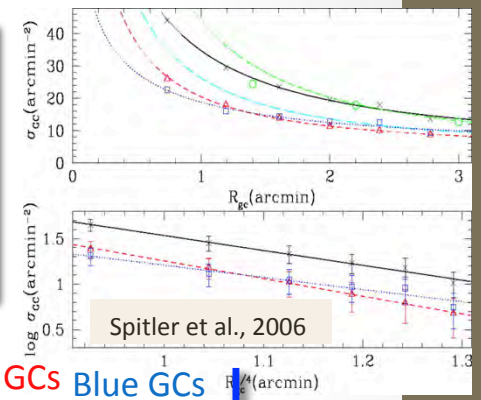
...and they have many interesting properties



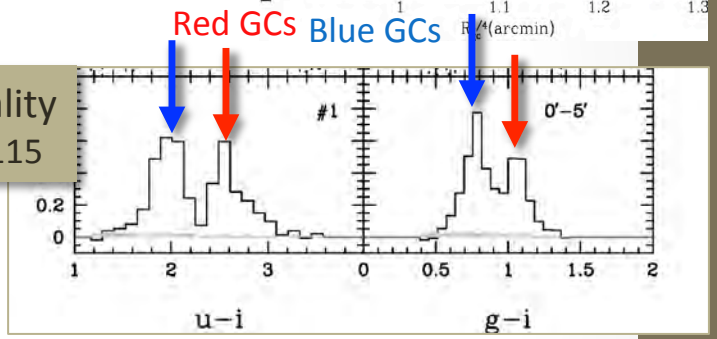
GCLF Luminosity Function of GCs Distance Indicator

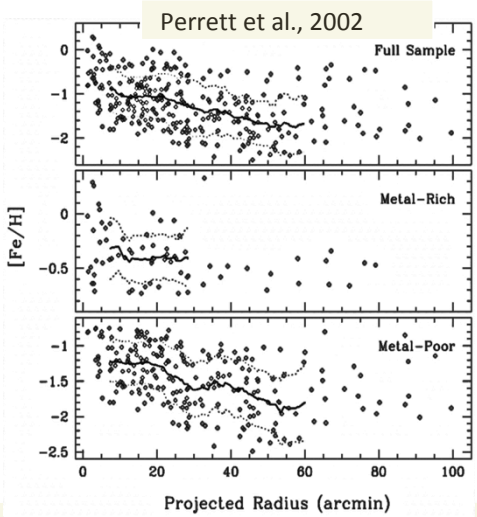
GC log-normal "Initial Mass Function"

Surface density: power law with flat cores



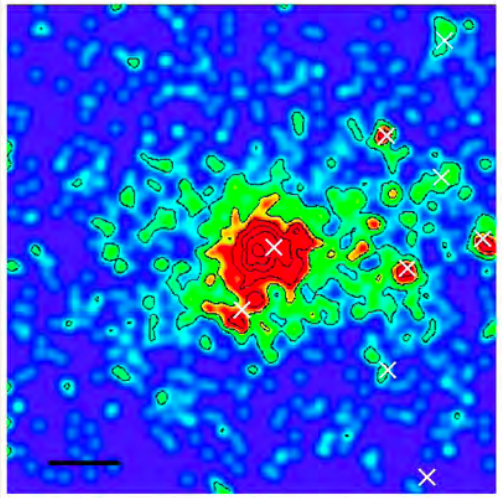
Color bimodality
VEGAS/NGC3115





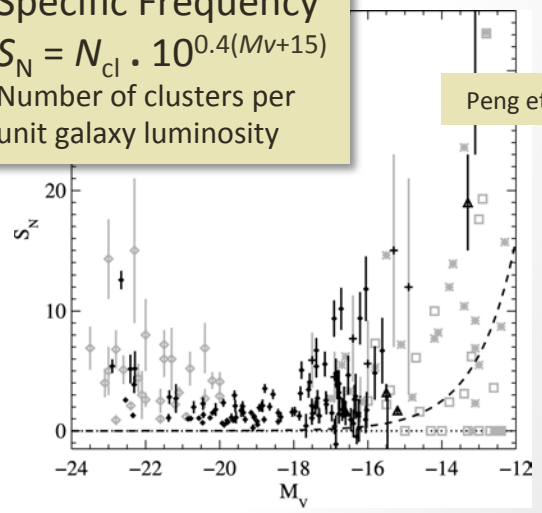
Radial colour/[Fe/H] profiles. Abundance gradients for GCs as for field stars?

FDS/NGC1399
Cantiello et al., 2018



Extended Environment

Specific Frequency
$S_N = N_{cl} \cdot 10^{0.4(Mv+15)}$
Number of clusters per unit galaxy luminosity

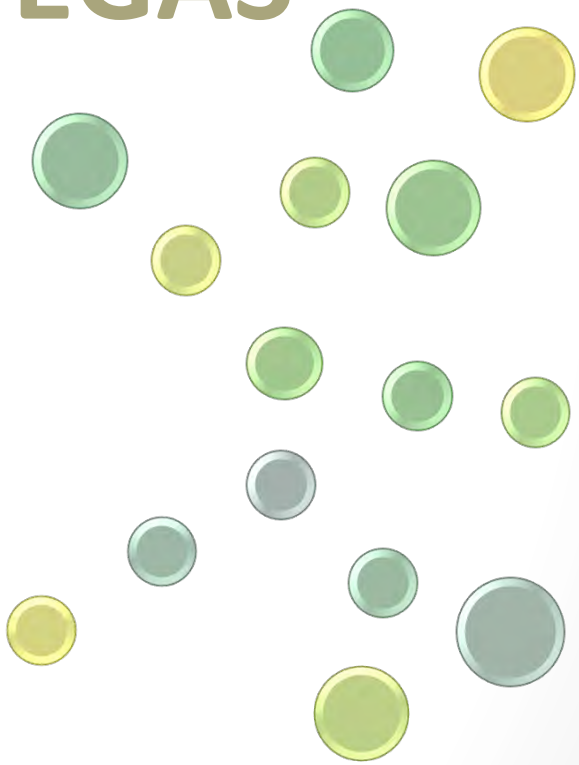


Globular Clusters with VST

Decontamination two different cases

FDS

VEGAS



VEGAS: (relatively) isolated galaxies

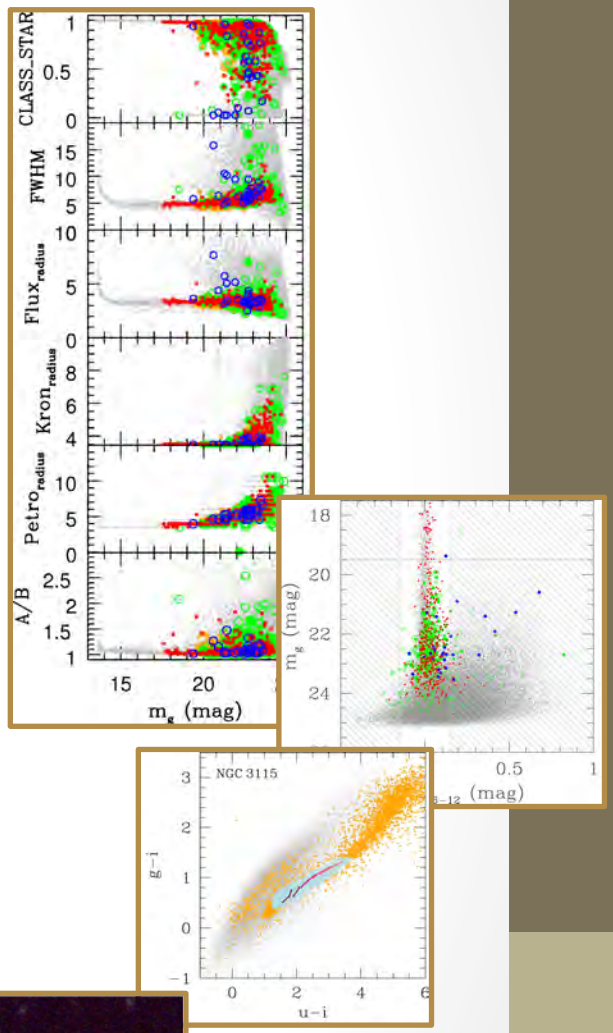
Or how to Get Rid of Contaminants

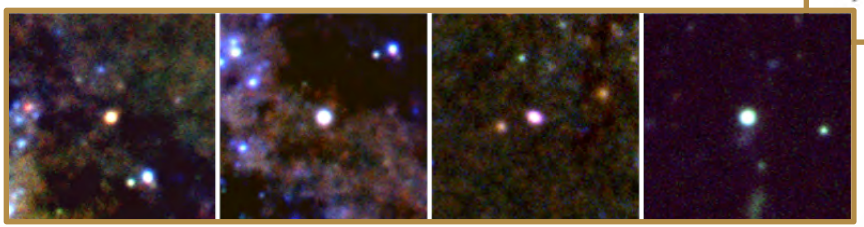
Shape
- **Compactness & other morphometric properties**

Mags
- **Magnitude range for candidates**

Colors
- **Optical & (ideally) near-IR colors**

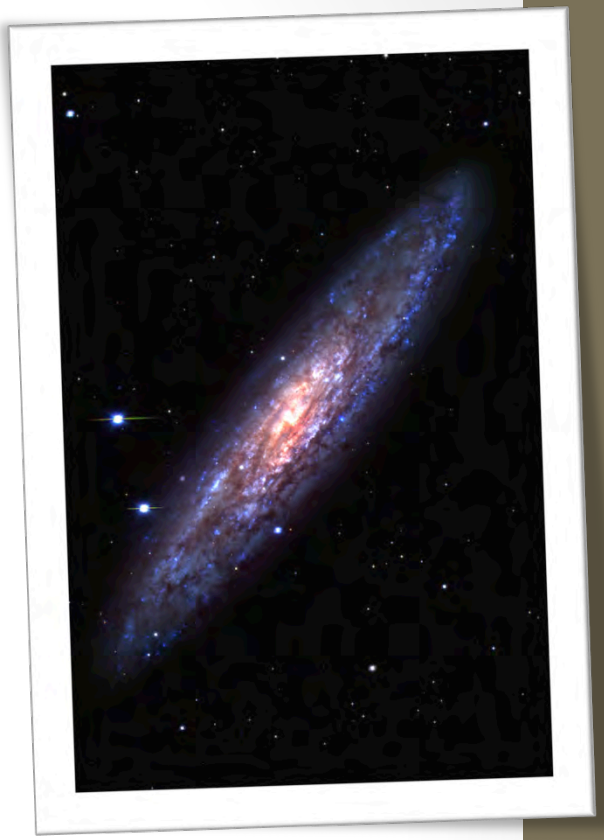
Visual inspection
- **Ideal, feasible only in some cases**

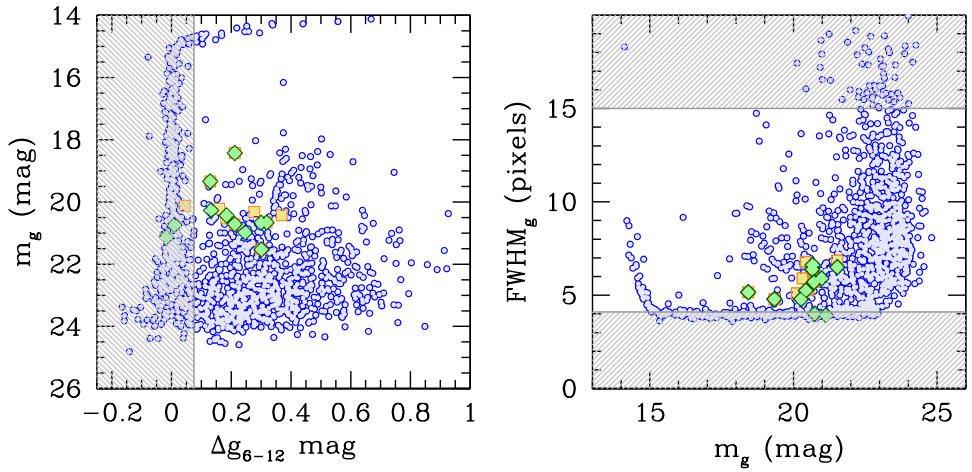


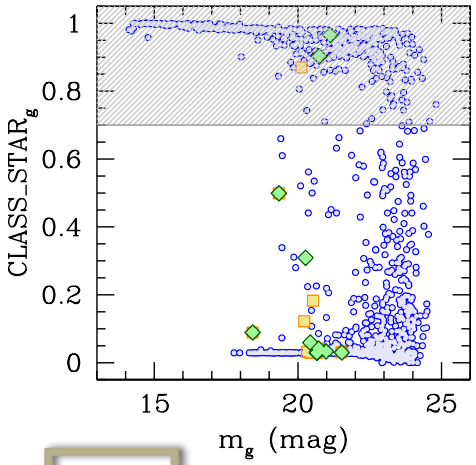


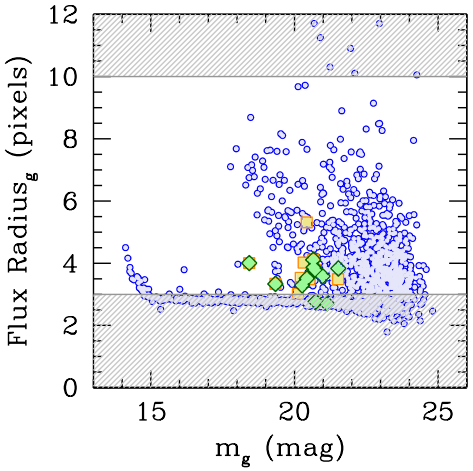
A special case: NGC253

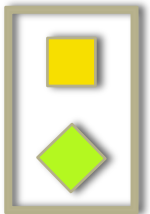
ugri VST & JK from VISTA











Spectroscopically confirmed GCs

~1500 pre-selected sources

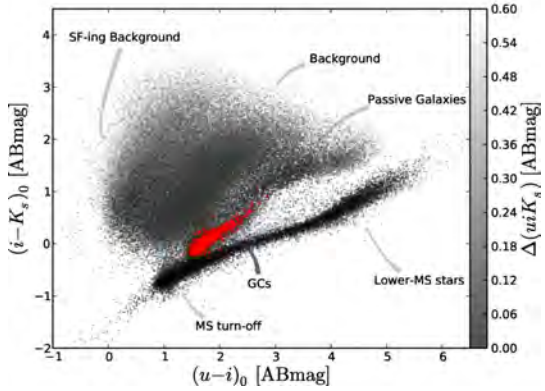
Morphometric & Magnitude selections

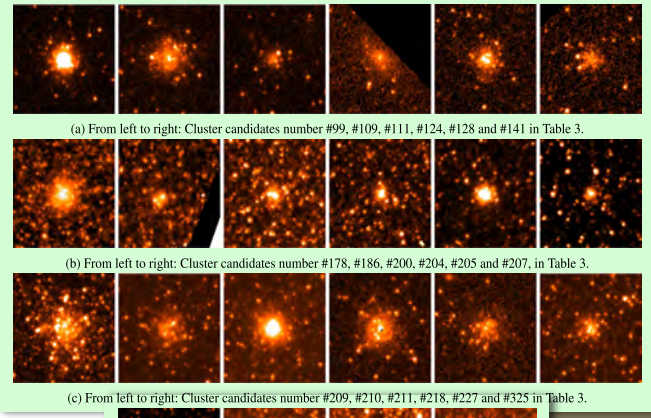
- ✓ Concentration index & compactness
- ✓ GCLF for magnitude range (m_{Bright}/m_{Faint})
- ✓ Others (~redundant)

A special case: NGC253

ugri VST & JK from VISTA too

PRINTED SLIDE

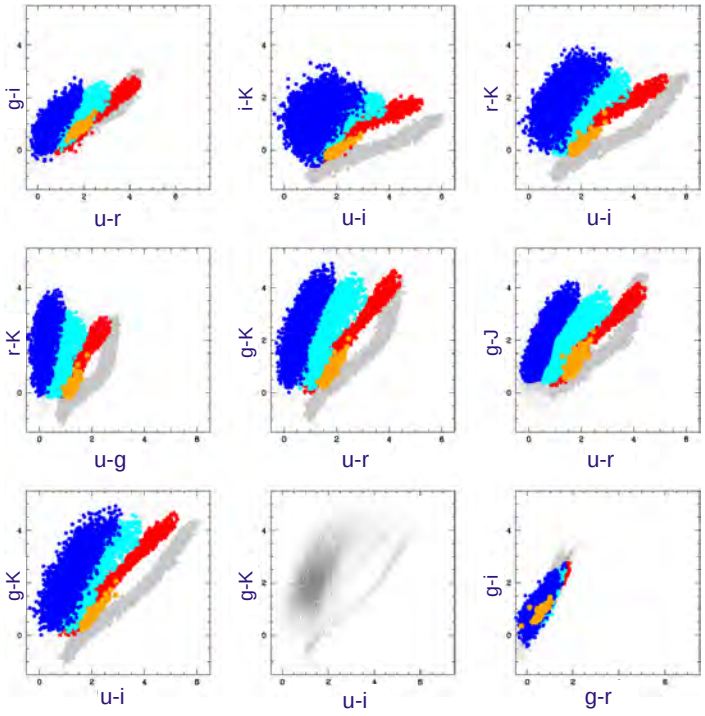



(a) From left to right: Cluster candidates number #99, #109, #111, #124, #128 and #141 in Table 3.

(b) From left to right: Cluster candidates number #178, #186, #200, #204, #205 and #207, in Table 3.

(c) From left to right: Cluster candidates number #209, #210, #211, #218, #227 and #325 in Table 3.

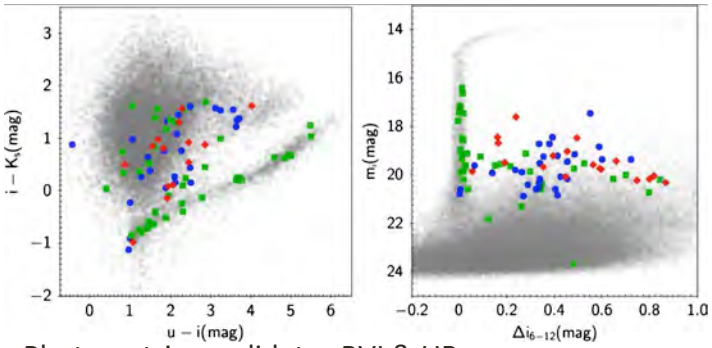
(d) From left to right: Cluster candidates number #333, #334, #335 and #336 in Table 3



Color-color selections

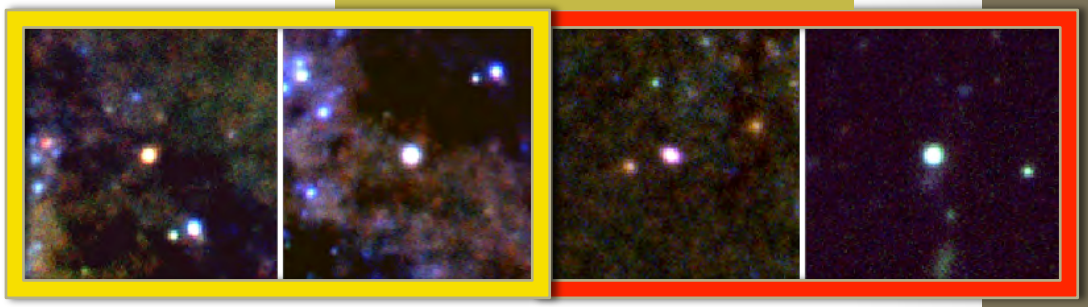
- ✓ Munoz et al. (2014): uiK diagram for NGVS
- ✓ Multiple colors u to K
- ✓ ~350 sources selected (morpho-photometric & color selections)
- ✓ Only ~240 passed visual inspection

NGC253: Residual contamination



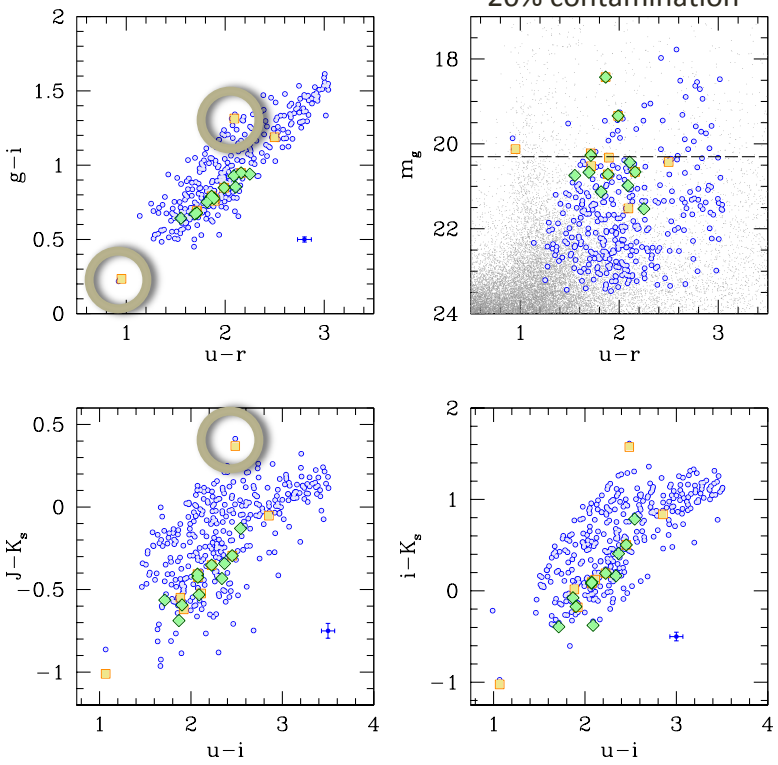
Photometric candidates BVI & UR
Huge contamination

Spectroscopically classified as GCs
MW Stars Background galaxies

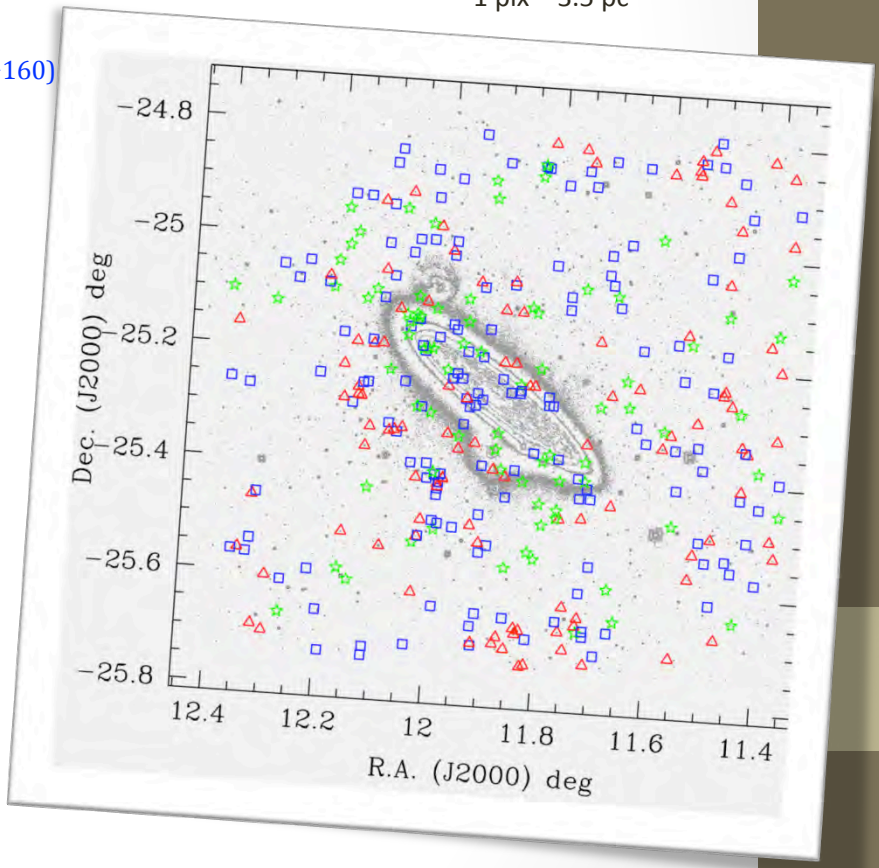


1 pix ~ 3.5 pc

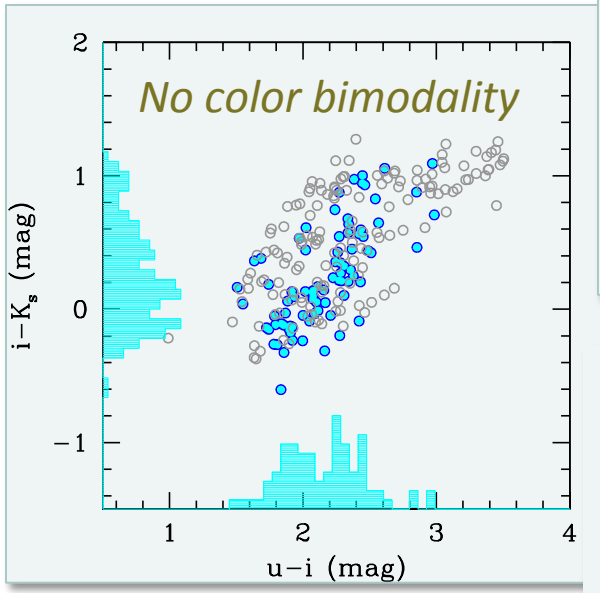
Spectroscopic candidates
~20% contamination

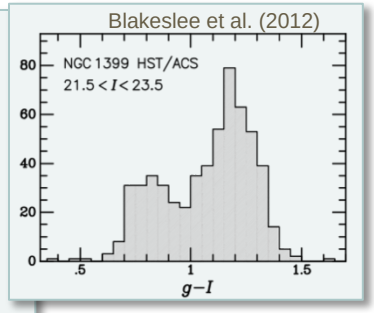


★: good (~80)
□: uncertain (~160)
Δ: bad (~110)



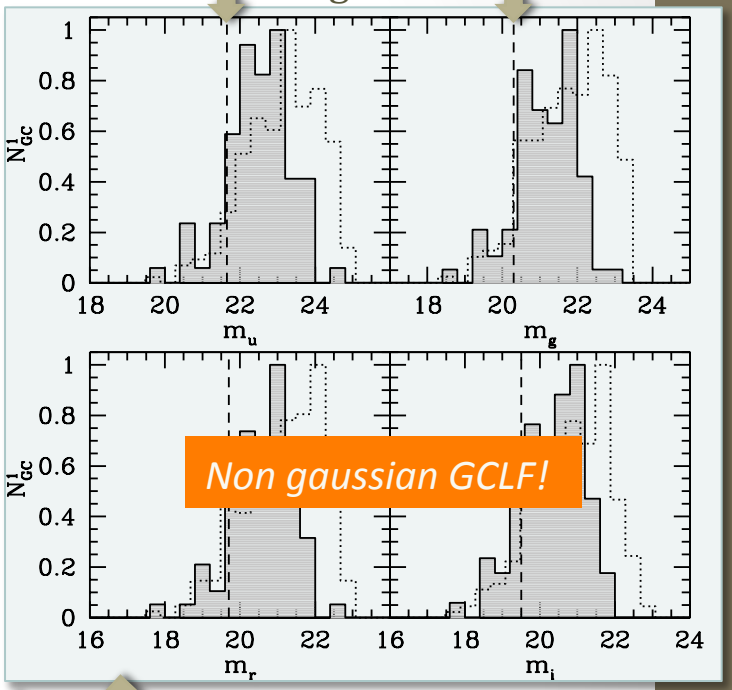
NGC253 results





No consistent color bimodality in the various inspected colors (projection scenario?)
[Yoon+06, Cantiello & Blakeslee 07]

Turn Over Magnitude

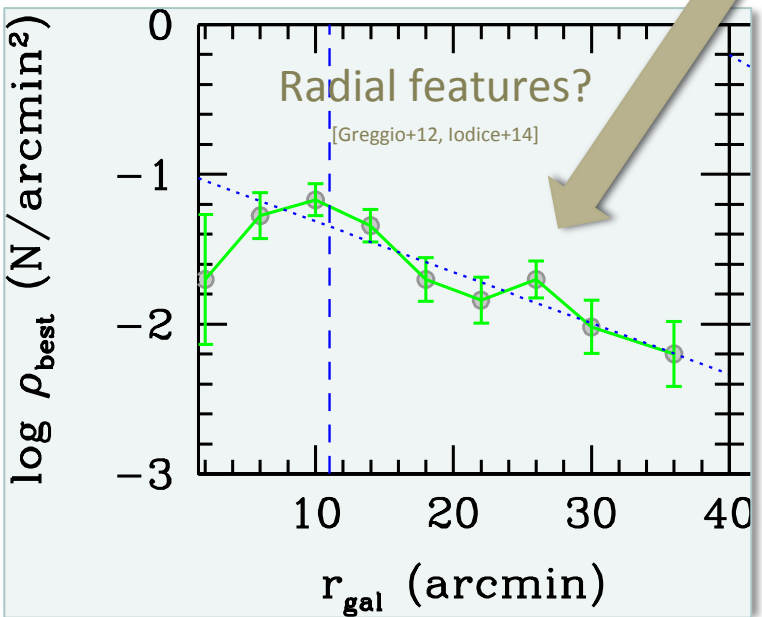


N_{tot} & S_N

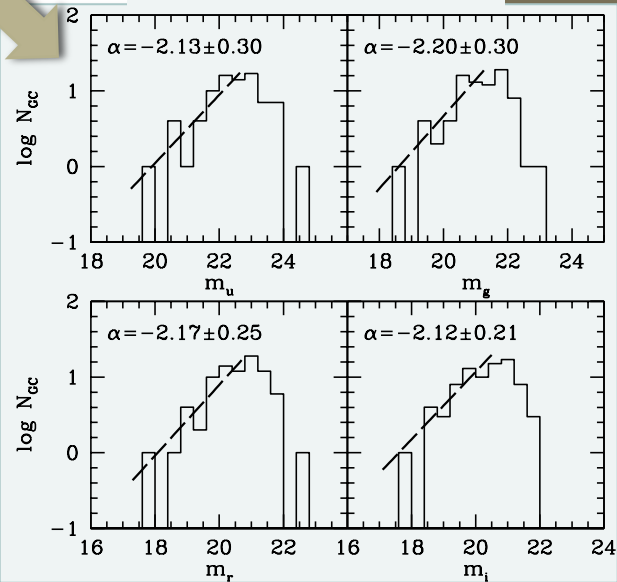
Estimated number of total GCs: N_{tot}~100

Normal Specific frequency: S_N~0.5

Low; but similar to similar galaxies (M101, NGC6956)

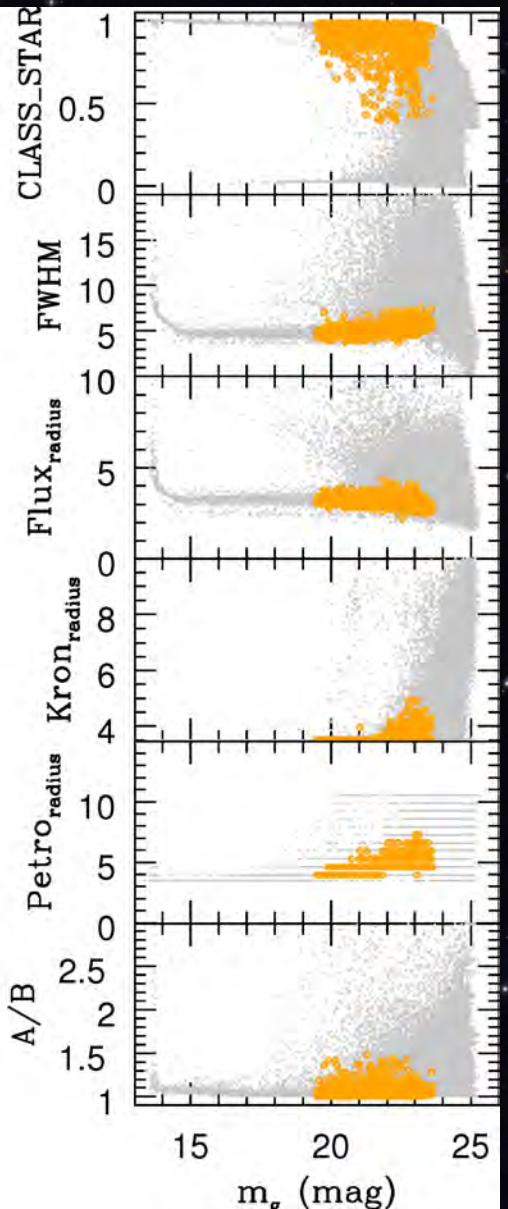


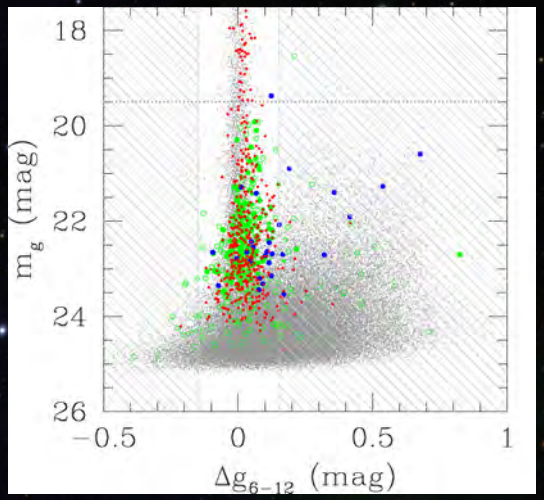
LMC power law LF?



NGC3115: Isolated with no surprises

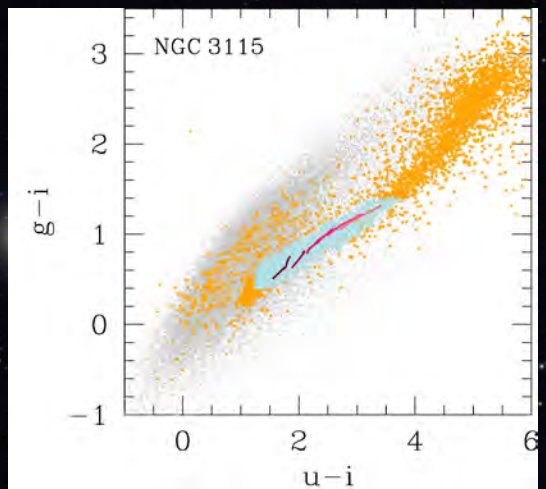
GC properties by background subtraction



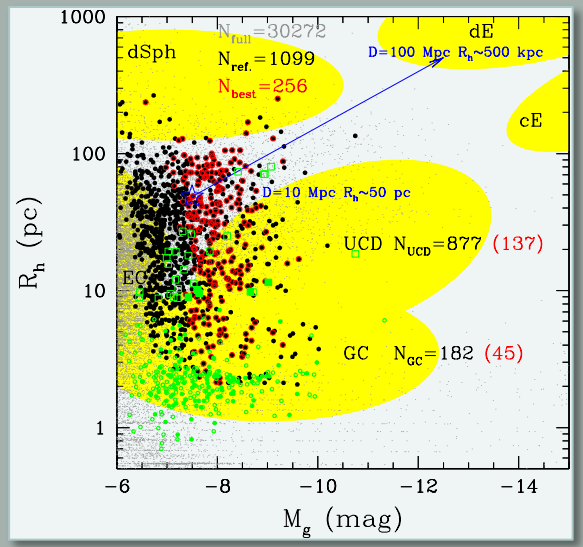


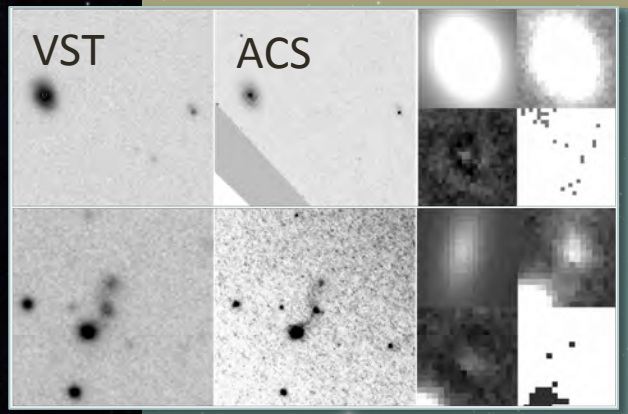
Morpho- & photometric selection
Too far for resolving GCs.

Large contamination



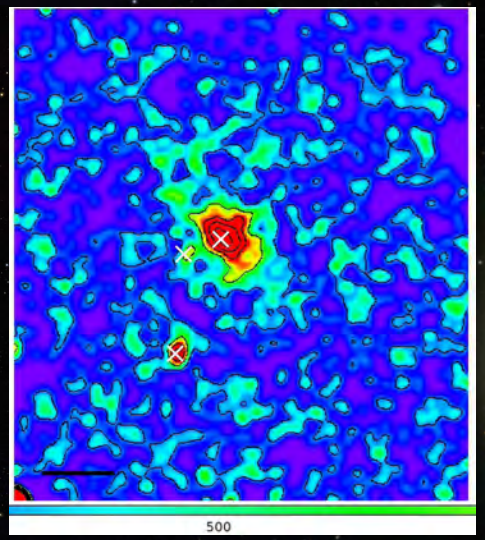
Size-based selection



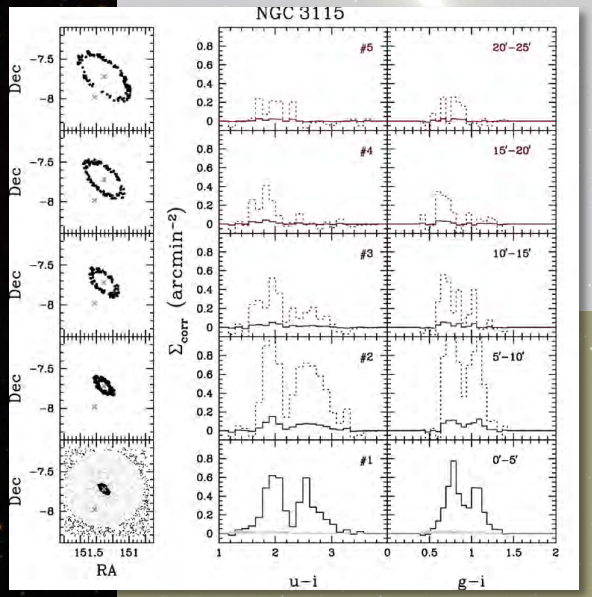


NGC3115: Isolated with no surprises

GC properties by background subtraction

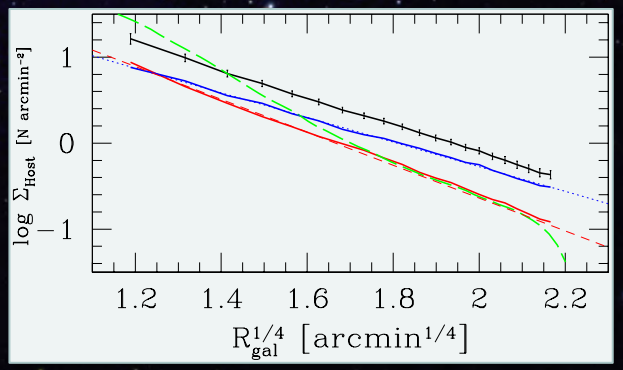


Bimodal color distribution coherent over all inspected colors (JHK too) [Cantiello+14]

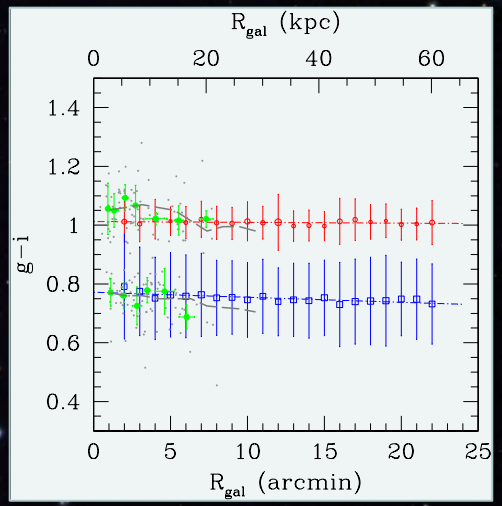


Radial density profile

- Red GCs: galaxy light
- Blue GCs: shallower
- Total: shallower than galaxy light toward galaxy center

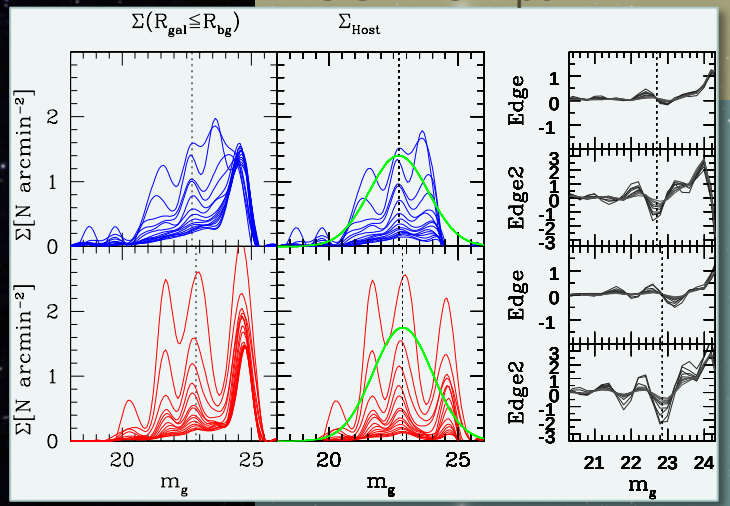


Radial color profile(s)

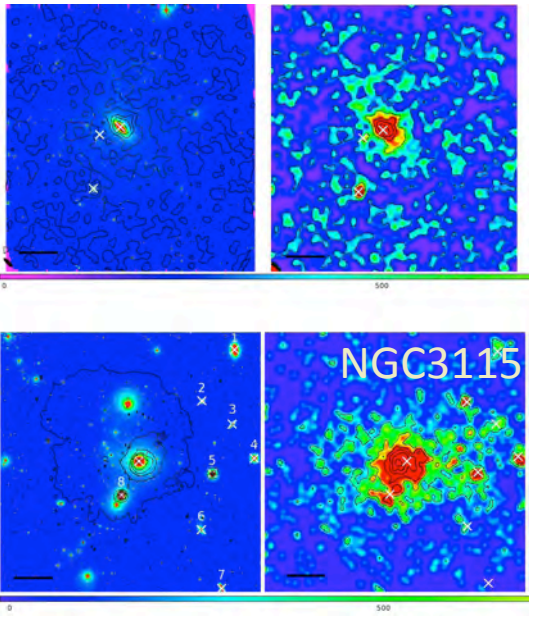


Blue/Red GCLF: Δ_{TOM}~0.1

D=9.8 ± 1.5 Mpc



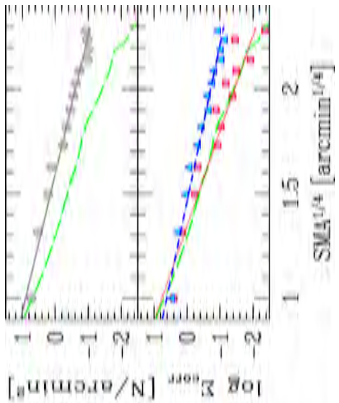
NGC3115 (VEGAS) & NGC1399 (FDS) PRINTED

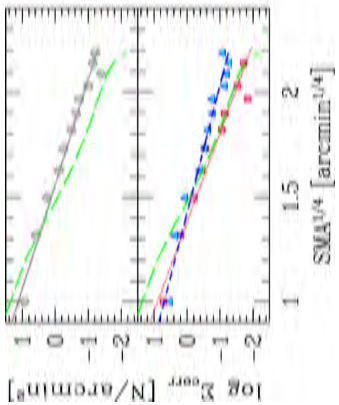


M&P selection +
Background subtraction

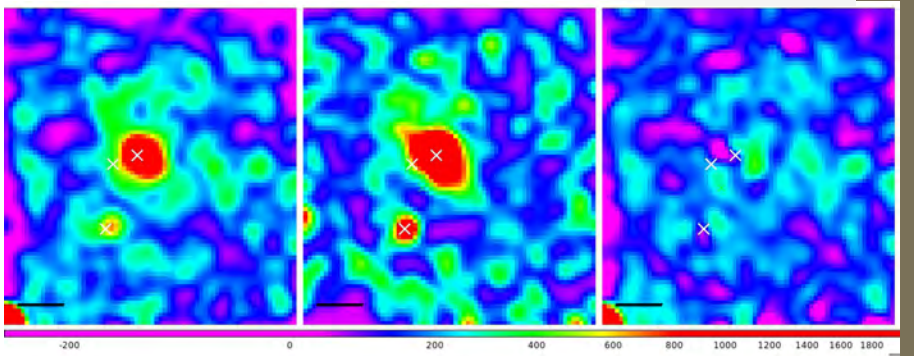
✔ Ok VEGAS (most cases)

✔ FDS…

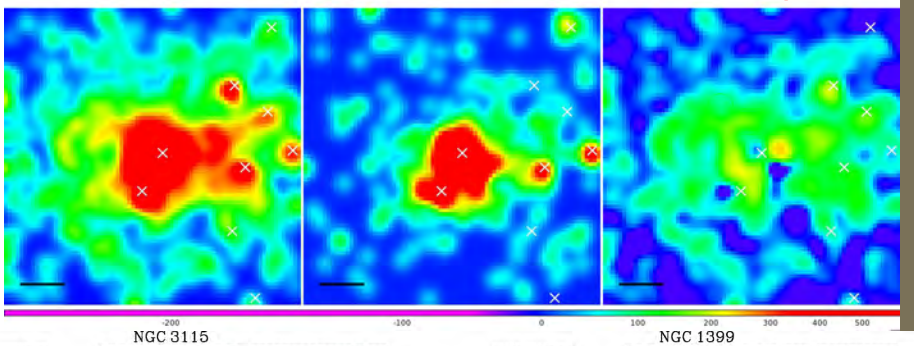




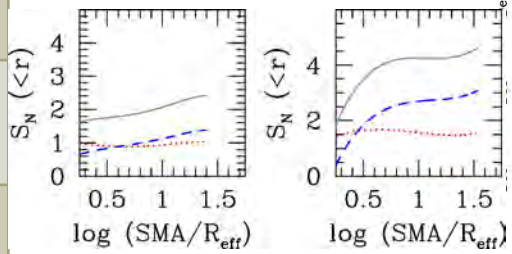
Red GCs | Blue GCs | Δ=residual

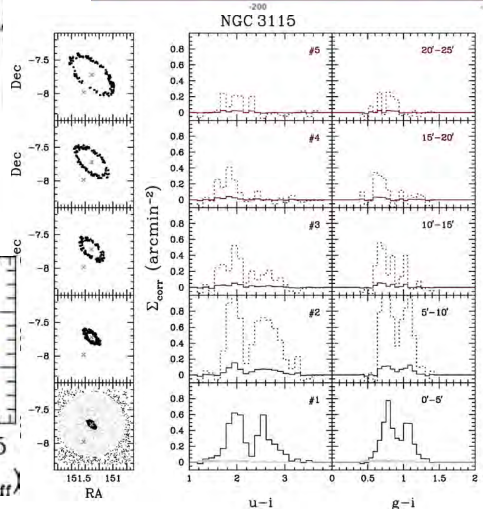


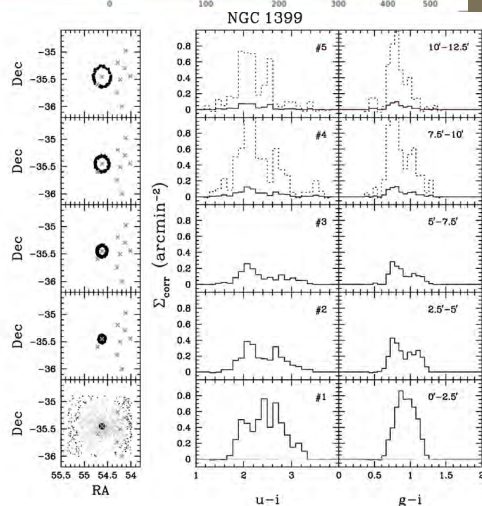
α blue− β red



NGC3115	NGC1399
Isolate	Cluster
MB=-XX	-YY
Coherent Color Bimodality	Color Bimodality? Not trivial [Blakeslee+12]
Radial GC profile ~r1/4 similar to galaxy light, shallow & extended blue, peaked red	
Similar Radial trends SN(<r)	







Conclusions & Ideas

Thanks

VEGAS

- **~130 galaxies** with different filter coverage, distance, enviromnents, out to 200Mpc
- GC science by 'background subtraction' + other classical selection methodologies
- NGC253/NGC3115/NGC5018(wip)…
- All procedures available. Implement them in VST-Tube?
- K band VISTA follow-ups?

FDS

- **~30 sq. degrees** ugri most, only gri for Fornax A
- Presently working on the procedures for a catalogue as complete, uniform, and contaminant-free as possible.
- Some results (NGC1399, MP) already available.
- Procedures available. Implement them in VST-Tube