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Formation and Evolution of Star Clusters in Chile, May 14-16, 2014

Extended Star Clusters in NGC 1023 from HST/ACS Mosaic Imaging

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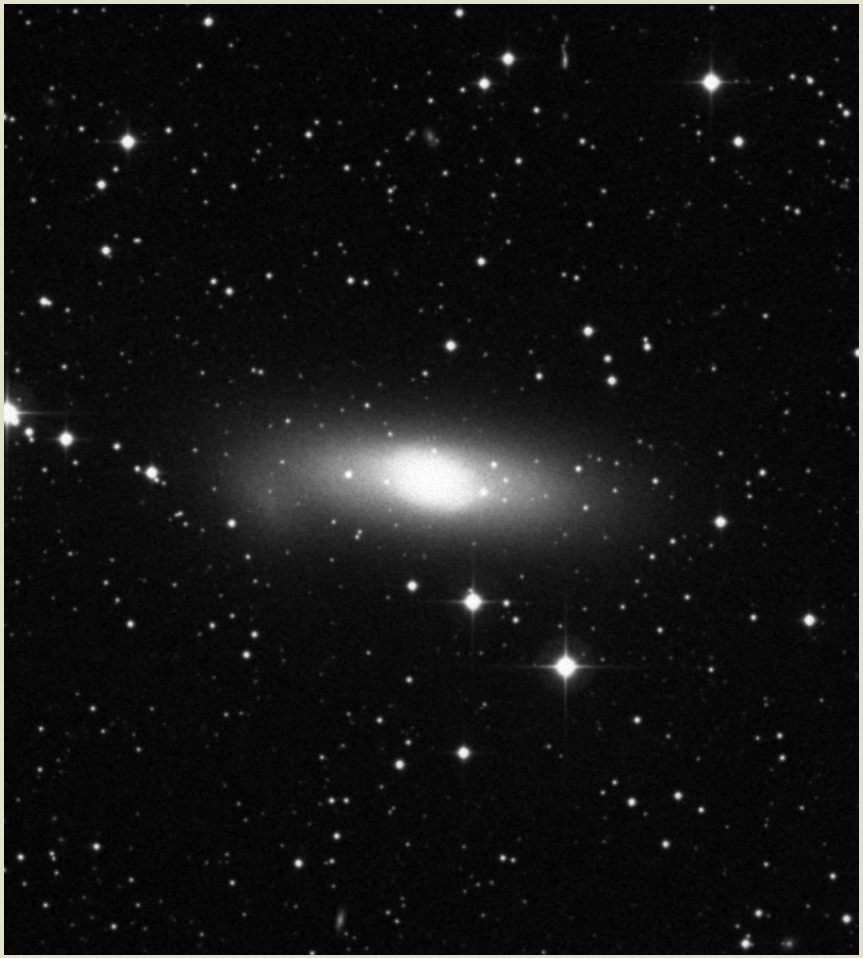
Introduction

- Discovery of star clusters in the nearby S0 galaxy NGC 1023
- Normal globular clusters (GCs) as well as a population of faint objects with large sizes
- Faint objects: Faint Fuzzies (FFs), a relatively new type of star clusters
- Effective radii of 7-20 pc
- Low surface brightness

Faint Fuzzies

- First found by Larsen & Brodie (2000) in the S0 galaxy NGC 1023
- Mean colour V-I=1.3
- High metallicity and old ages
- Red FFs lie in a fast rotating structure (Burkert et al. 2005)
- FFs appear to be old open custers associated with disks in lenticular galaxies

NGC 1023

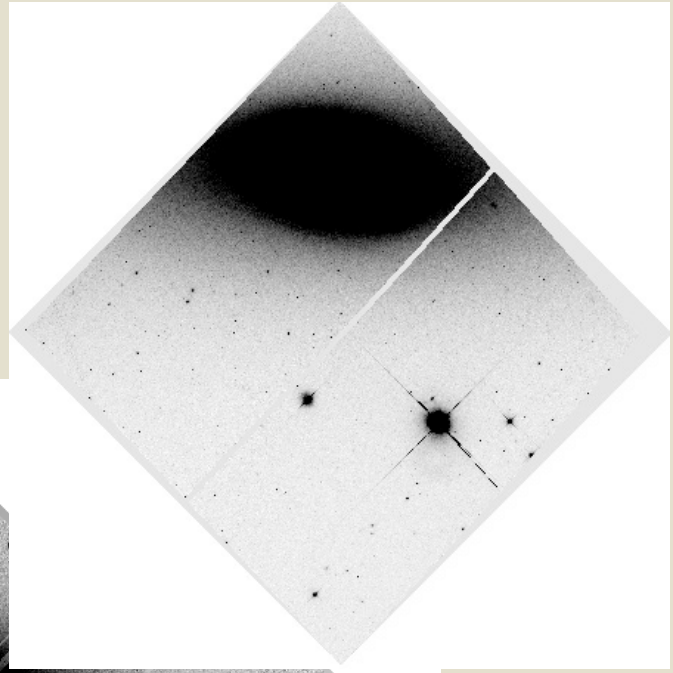


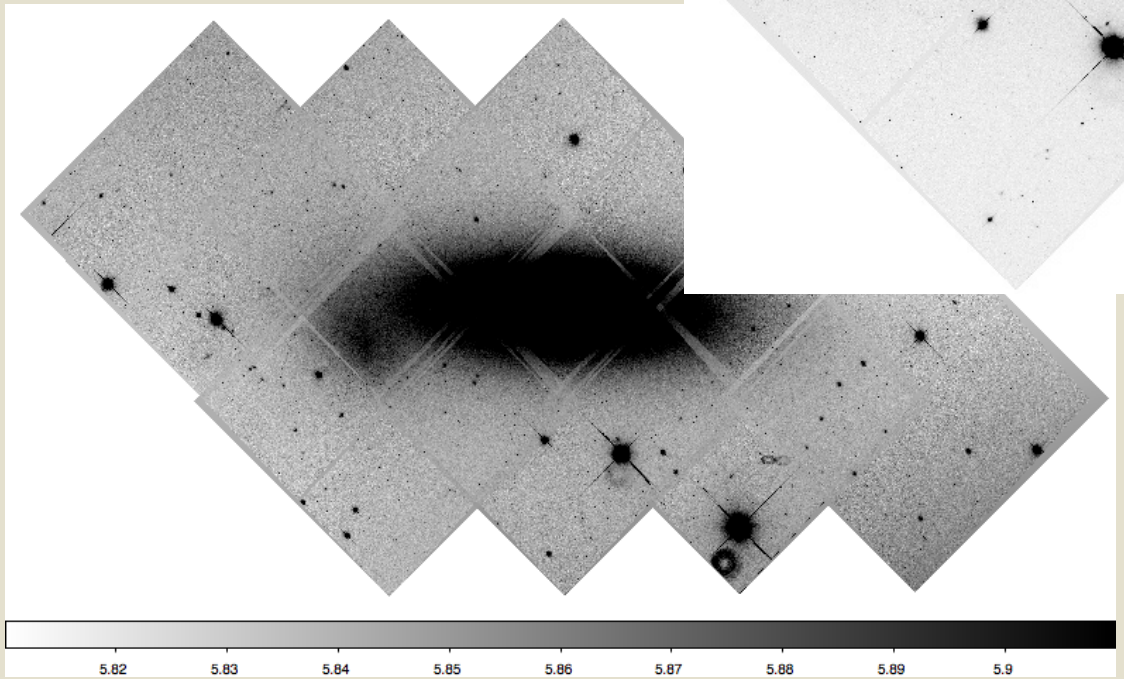
From the Digitized Sky Survey

- S0 morphology
- Coordinates (J200)
- RA: 02h40m24.010s
  DEC: +39d03m47.83s
- Distance: 11.1 Mpc
- Has a companion, dwarf galaxy NGC 1023A

Observations

- Data from 8 HST/ACS F475W (g) and F850LP (z) band images, proposal 12202 (PI: Sivakoff)
- Exposure time 768s in g band and 1308s in z band, per pointing
- Mosaic covering 12x7 sq. arcmins





Data Analysis

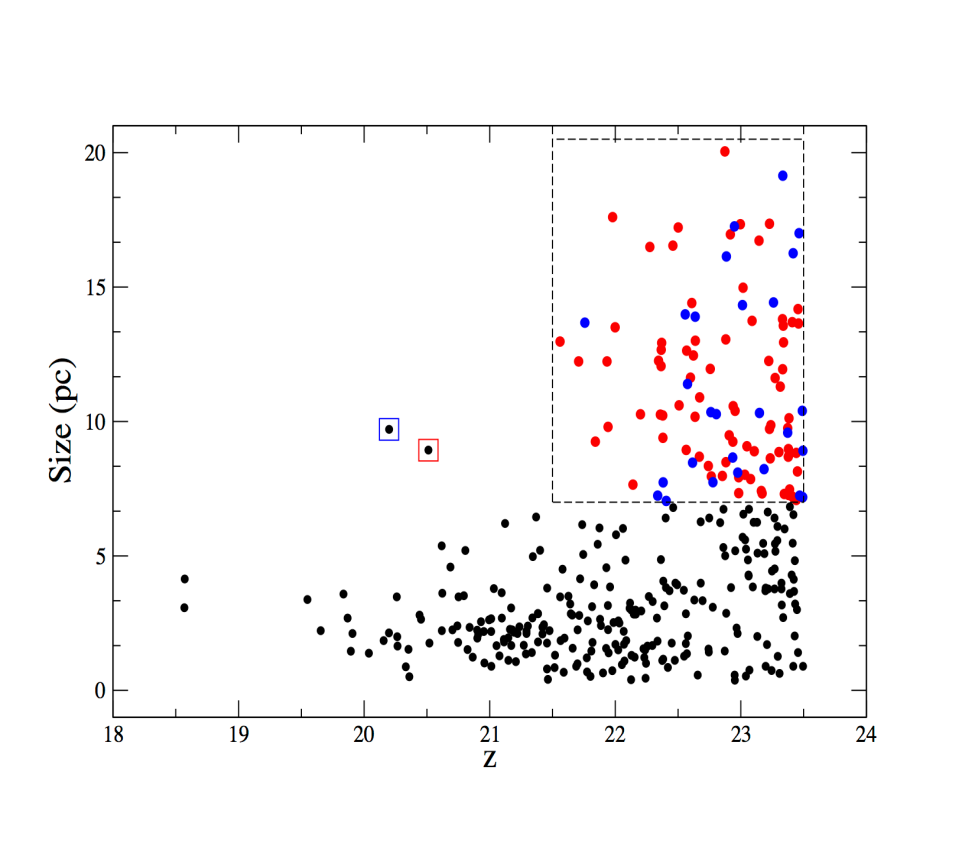
- Objects were detected using Sextractor
- Aperture photometry carried out with DAOPHOT
- Effective radii measured using ISHAPE code (Larsen 1999) with King profile concentration parameter fixed to 30

Selection Criteria

- Star cluster candidates were selected to have colours $0.6 < g-z < 1.8 \rightarrow -2.6 < [Z/H] < 1.1$ and faint magnitude cut of $z < 23.5$
- Effectively cut of photometric error of less than ±0.1
- A minimum size of 0.3 pc was used to remove stars
- No maximum size used

Results

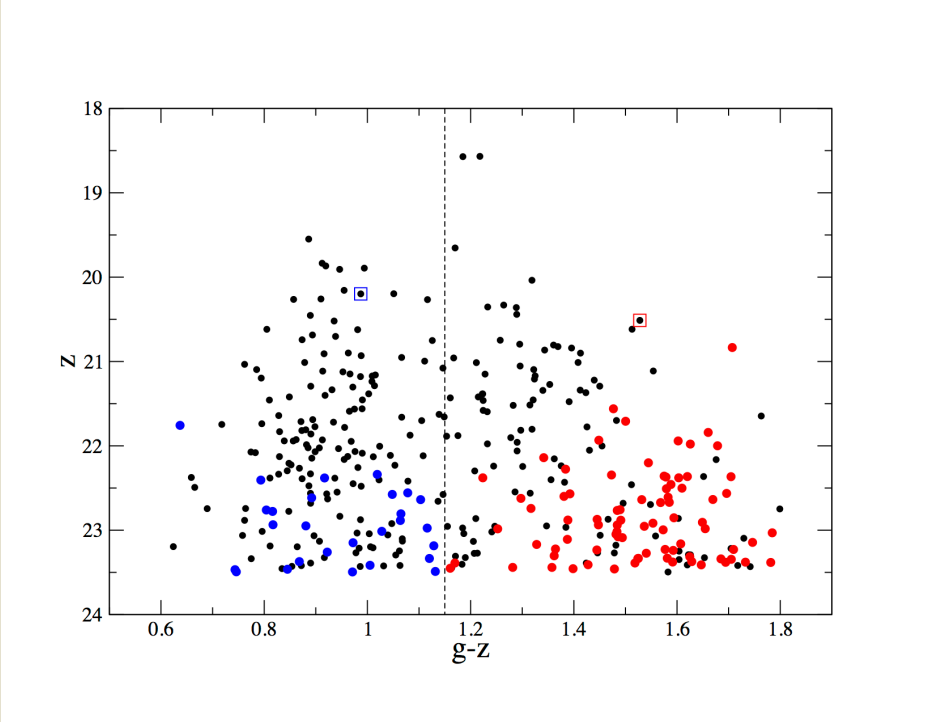
- Locus of objects with effective radius ~ 3 pc : GC candidates
- Objects with sizes > 7 pc are classified as FF candidates
- 109 FFs candidates found, 16 in common with Larsen & Brodie (2000)



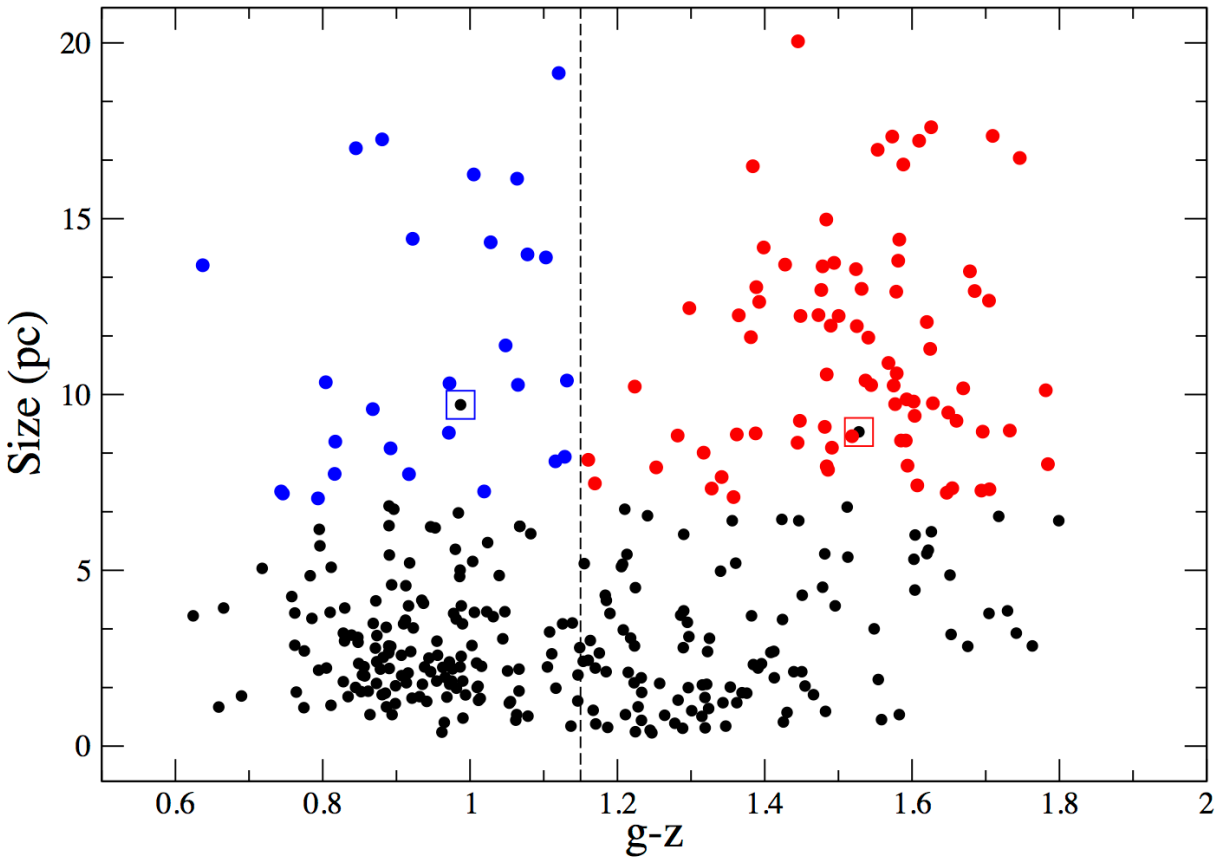
Star cluster candidates of NGC 1023. The box shows the selection criteria.

Cont.

- At least 2 subpopulations of GCs exist according to the CMD
- Colour cut g-z = 1.15 → [Z/H] ~-0.6
- 81 red FFs and 27 blue FFs candidates
- Red FFs have mean colours of g-z=1.52±0.01
- Blue FFs have mean colours of g-z=0.95±0.03
- From Keck spectra (Larsen & Brodie 2002) the red FFs are known to be metal-rich and old



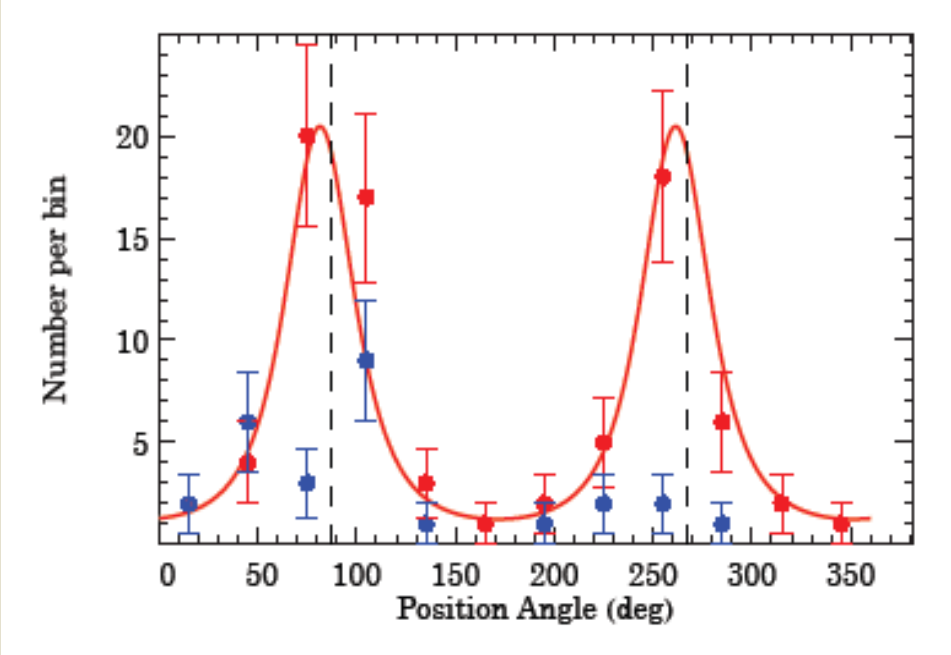
Colour magnitude diagram of the candidates. The dashed line in g-z=1.15 indicates the separation between red and blue candidates. Two bright globular clusters are visible with intermediate g-z colours



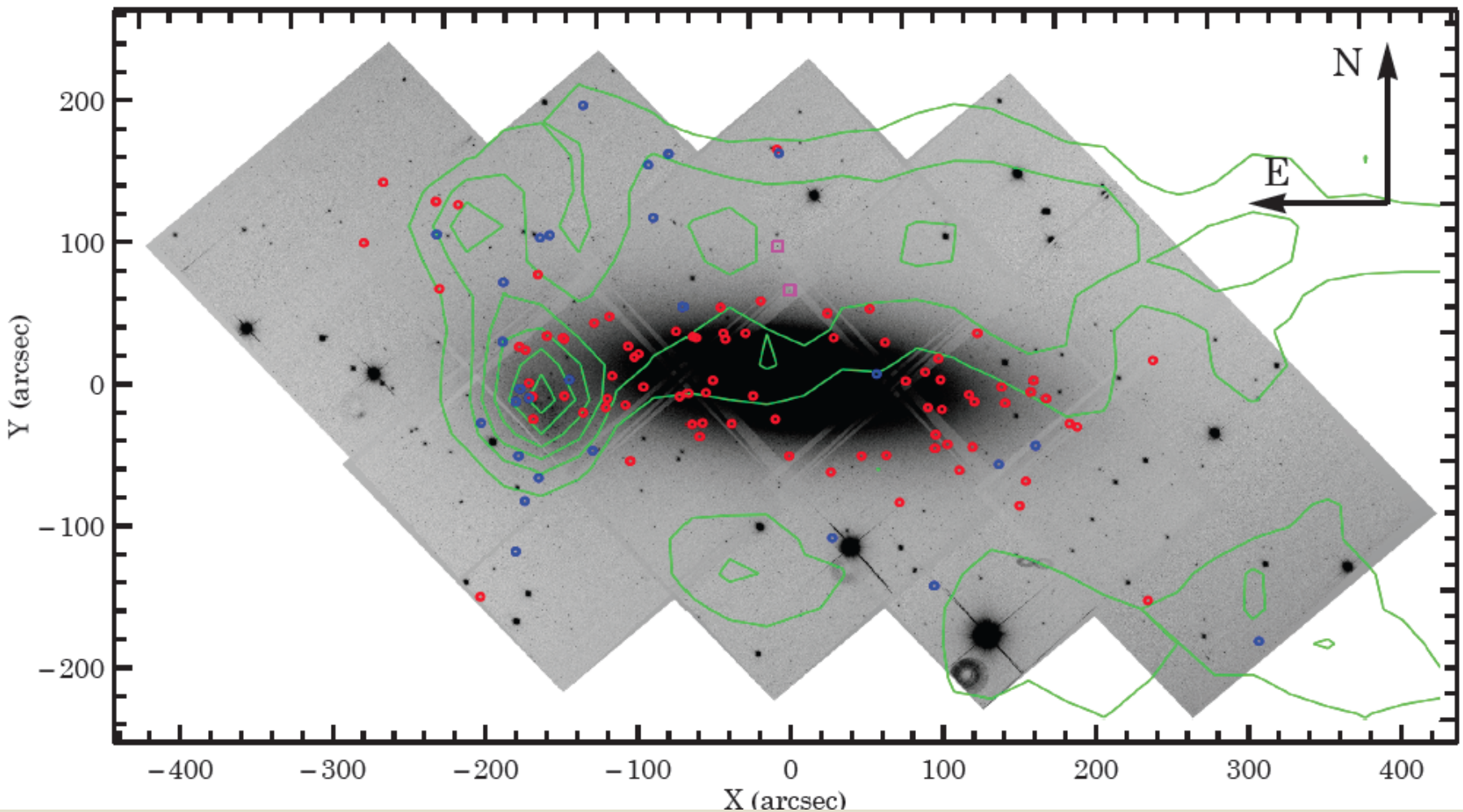
Star clusters candidates in NGC 1023. All the objects with size > 7 pc are shown with larger symbols. The dash line in g-z = 1.15 indicates the separation between red and blue candidates.

Cont.

- Red FFs spatial distribution PA = 82 ± 3 degrees and b/a = 0.4 ± 0.2. Stellar disk b/a = 0.26 and PA ~83 degrees
- Half of the blue FFs appear to be close to NGC 1023A
- Confirming previous works, red FFs have a disk-like distribution (Larsen & Brodie 2000)



Azimuthal distribution of the FFs. Dashed lines represent the PA of the major axis of NGC 1023: 85º and 265º.



HST/ACS mosaic of NGC 1023. Red circles shows the location of the red FF and the blue one shows the location of the blue FF candidates. The magenta squares shows the position of the 2 UCDs. The green contours indicates the distribution of high density HI (Morganti et al. 2006)

Conclusions

- We confirm the association of 81 red FFs with the disk of NGC 1023
- Consistent with being long-lived open clusters
- We also identify 27 blue FFs, half of them close to the dwarf satellite NGC 1023A

THANKS

A FF (candidate) and a bright GC