No (?) UCDs in the NGC 1023 group of galaxies

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6.12.2005, Santiago de Chile, ESO “groups” workshop

Outline of this talk:

1. Introduction to UCDs

2. A search for UCDs in the N1023 group
   (progress report)

1. Introduction to UCDs

Morphology:

Giant

Dwarf

Ultra-compact dwarf

1. Introduction to UCDs

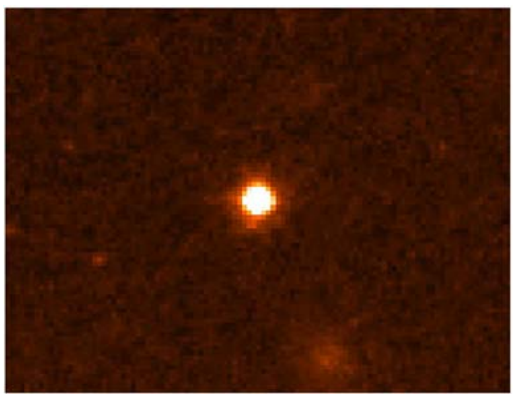
First discovery of UCDs in Fornax cluster:

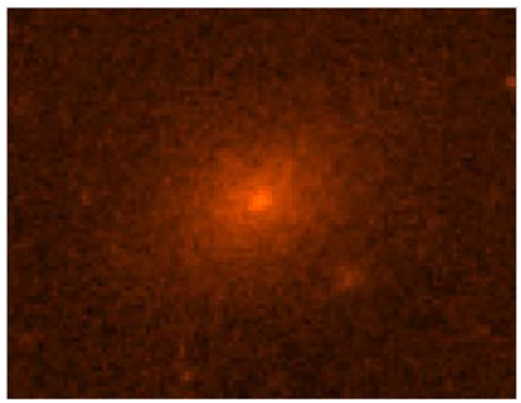
Hilker et al. (1999) and Drinkwater et al. (2000):
6 *unresolved* cluster members with $-13.5 < M_v < -12$ mag detected in all-object spectroscopic surveys of (central) Fornax cluster.

M_v like average dEs, but much smaller (r_h<50 pc).
--> Call them Ultra Compact Dwarf galaxies (UCDs)

Colours like metal-rich globular clusters, masses up to $5*10^7$ M_{sun}.

UCD





normal dE
of UCD luminosity

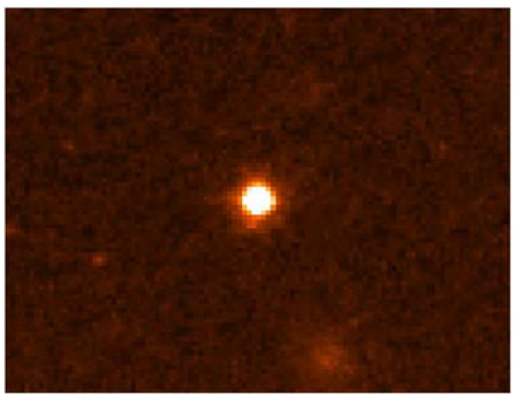
1. Introduction to UCDs

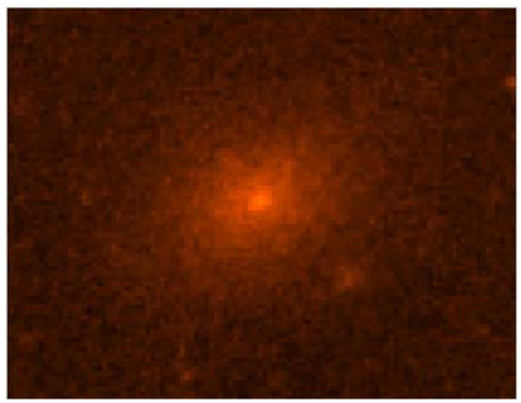
UCDs also discovered in the Virgo cluster:

Hasegan et al. (2005): several UCD cands detected in ACS Virgo Cluster Survey, based on larger sizes than GCs.
Bluer than Fornax UCDs.

Jones et al. (2005): seven UCDs discovered spectroscopically.
Same luminosity range as in Fornax.
Bluer than Fornax UCDs.

UCD





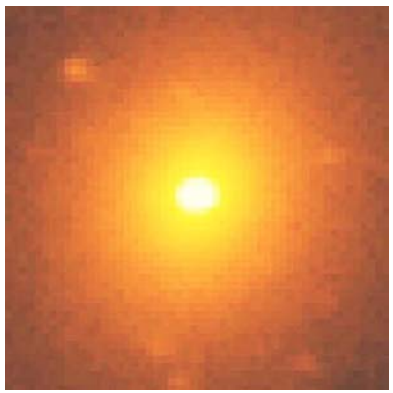
normal dE
of UCD luminosity

Possible origins of UCDs:

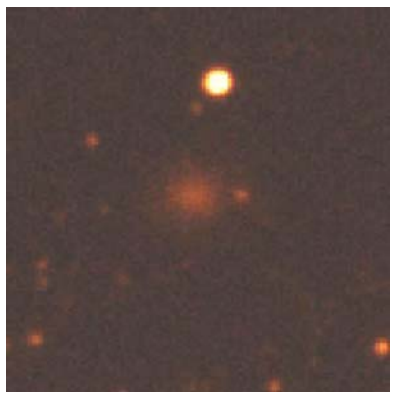
1. **Brightest globular clusters (LFs overlap)**
   (Mieske et al. 2002 & 2004; Dirsch et al. 2003)

2. **Stellar super-clusters created in mergers**
   Young massive clusters (YMCs) as UCD progenitors?
   (Fellhauer & Kroupa 2002, 2005; Kissler-Patig et al. 2005)

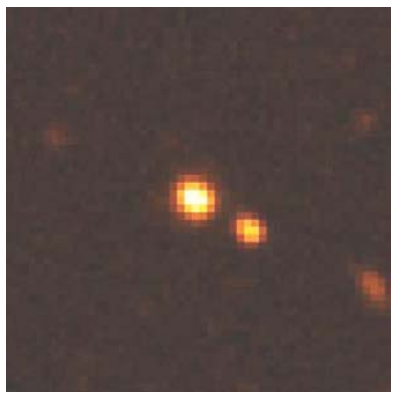
3. **Stripped nuclei of dE,Ns**
   (Bekki et al. 2003)



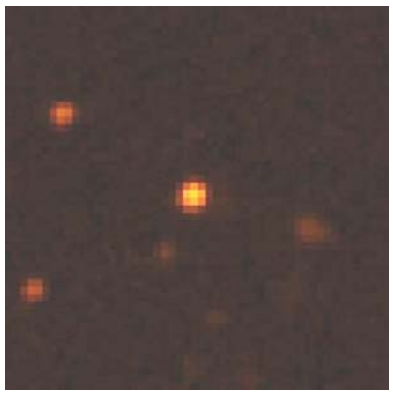
dE,N



dE

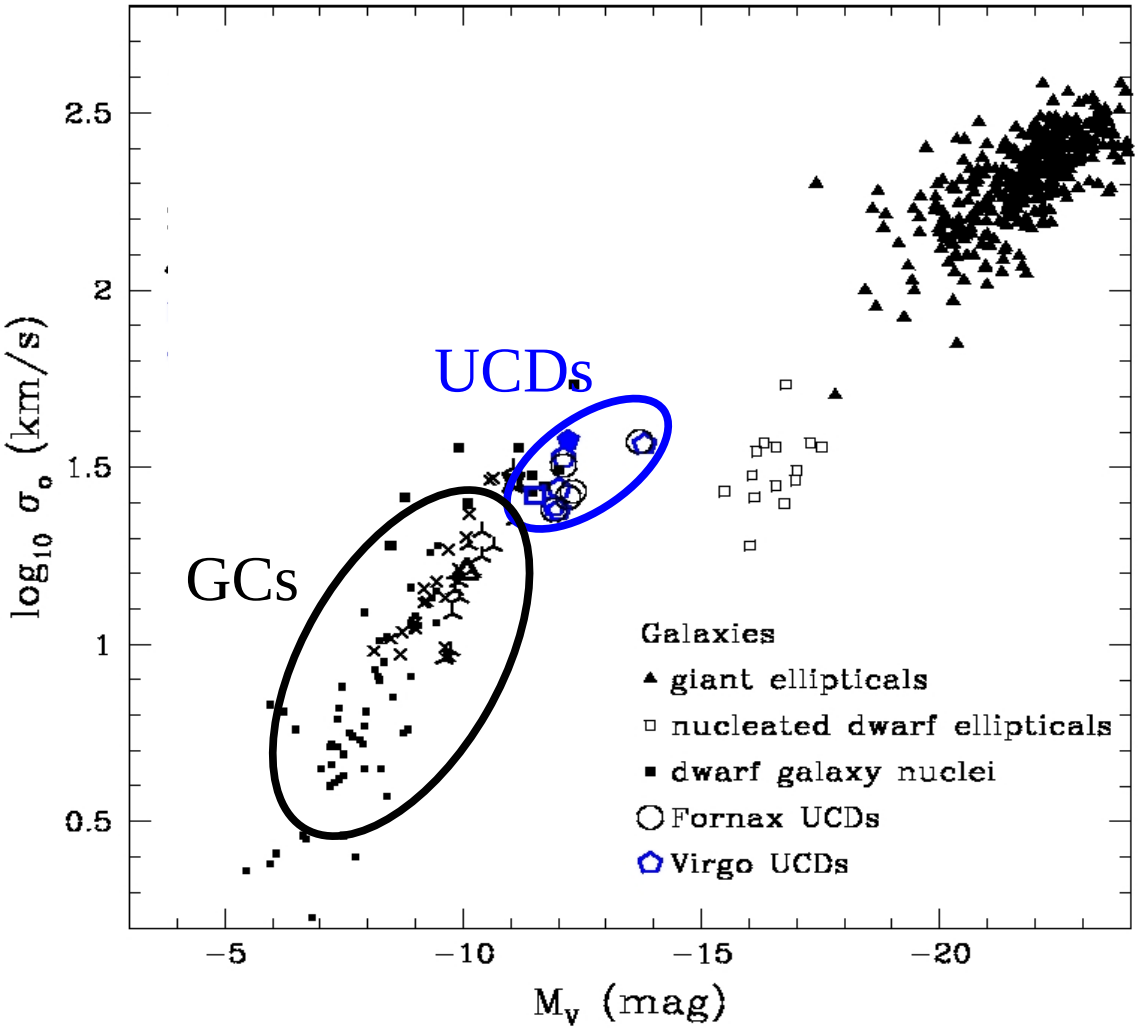


UCD



bright GC

High resolution photometry + spectroscopy:
UCDs beyond extreme end of GC mass-light-size space.



Fundamental Plane

Evstigneeva et al. (2005)

High resolution photometry + spectroscopy:
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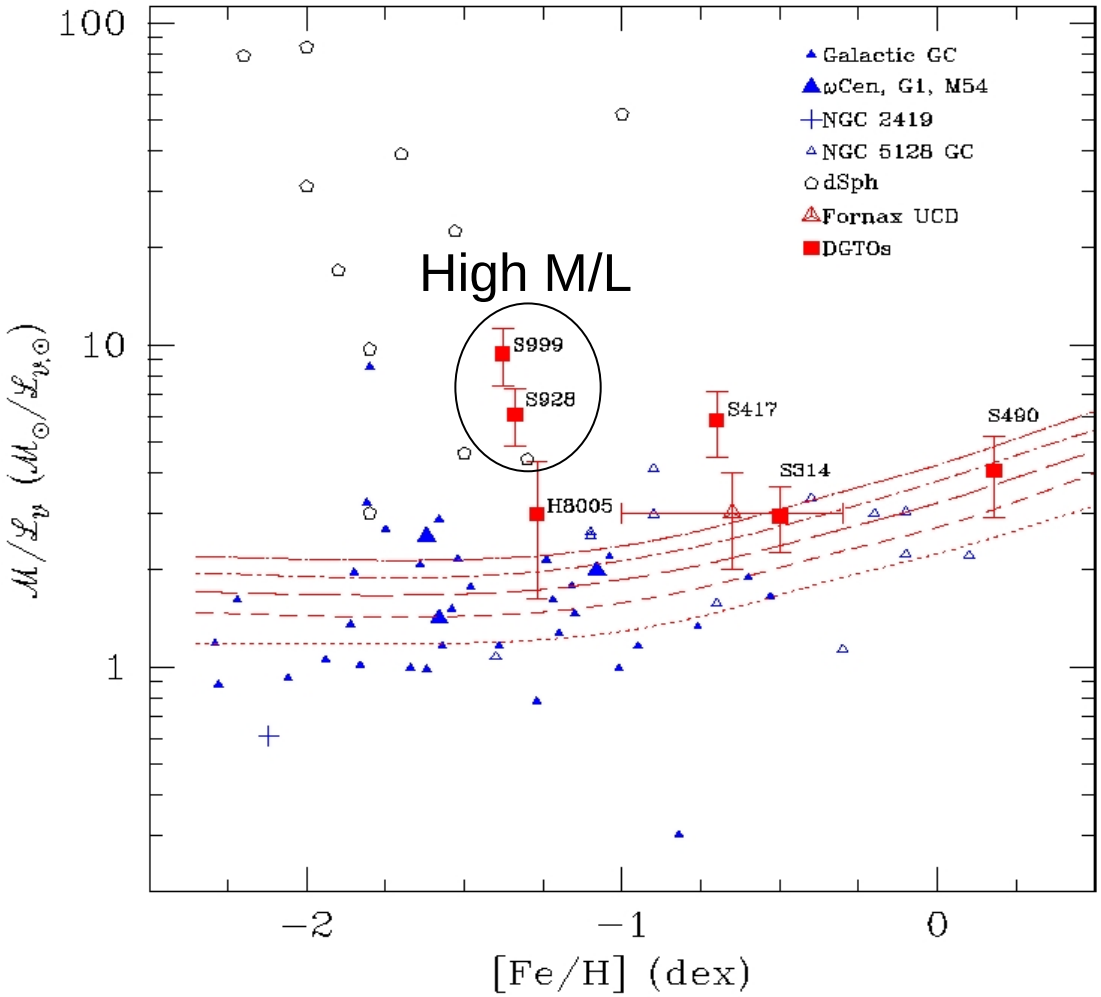
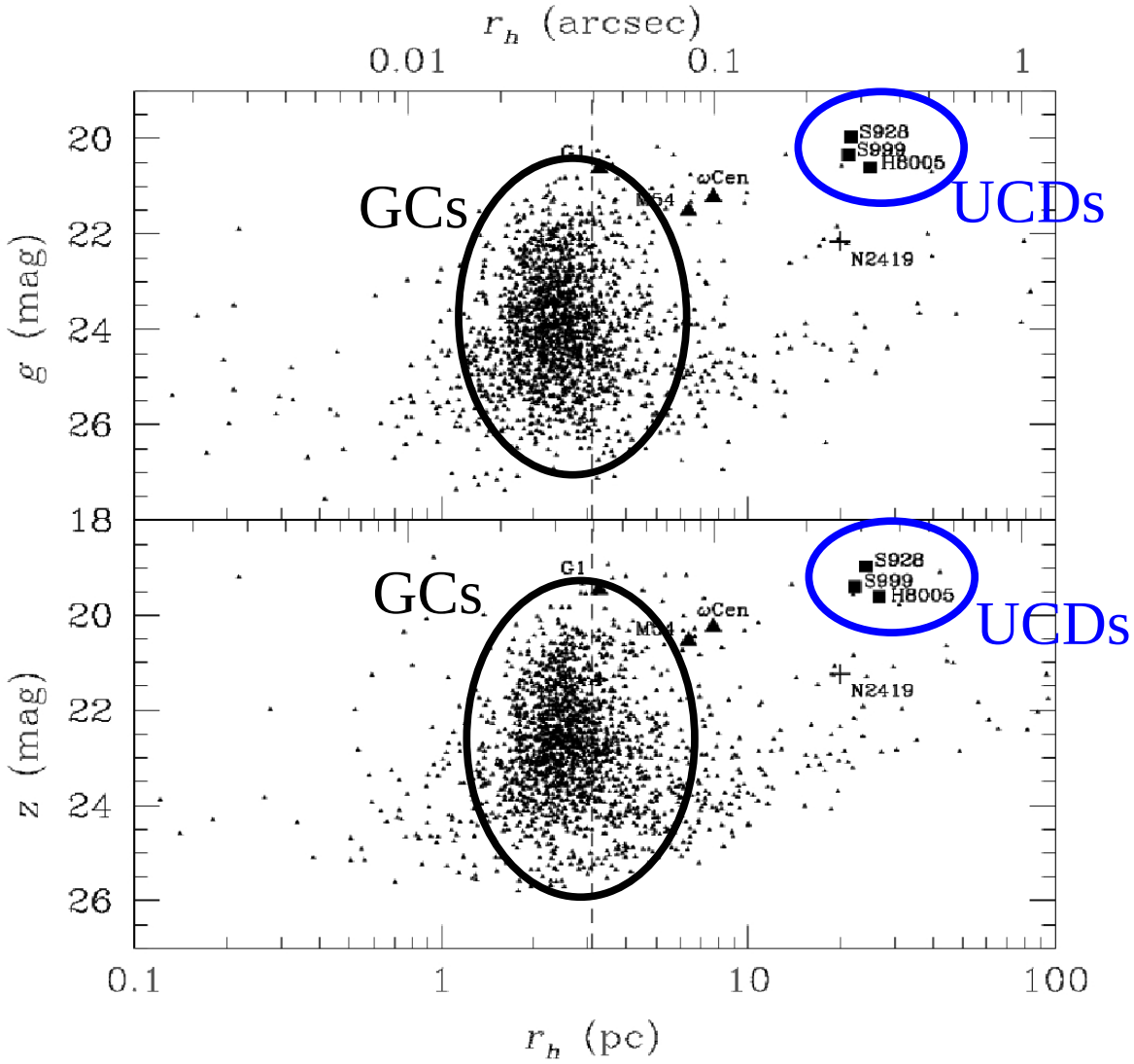


M/L ratios of Virgo UCDs

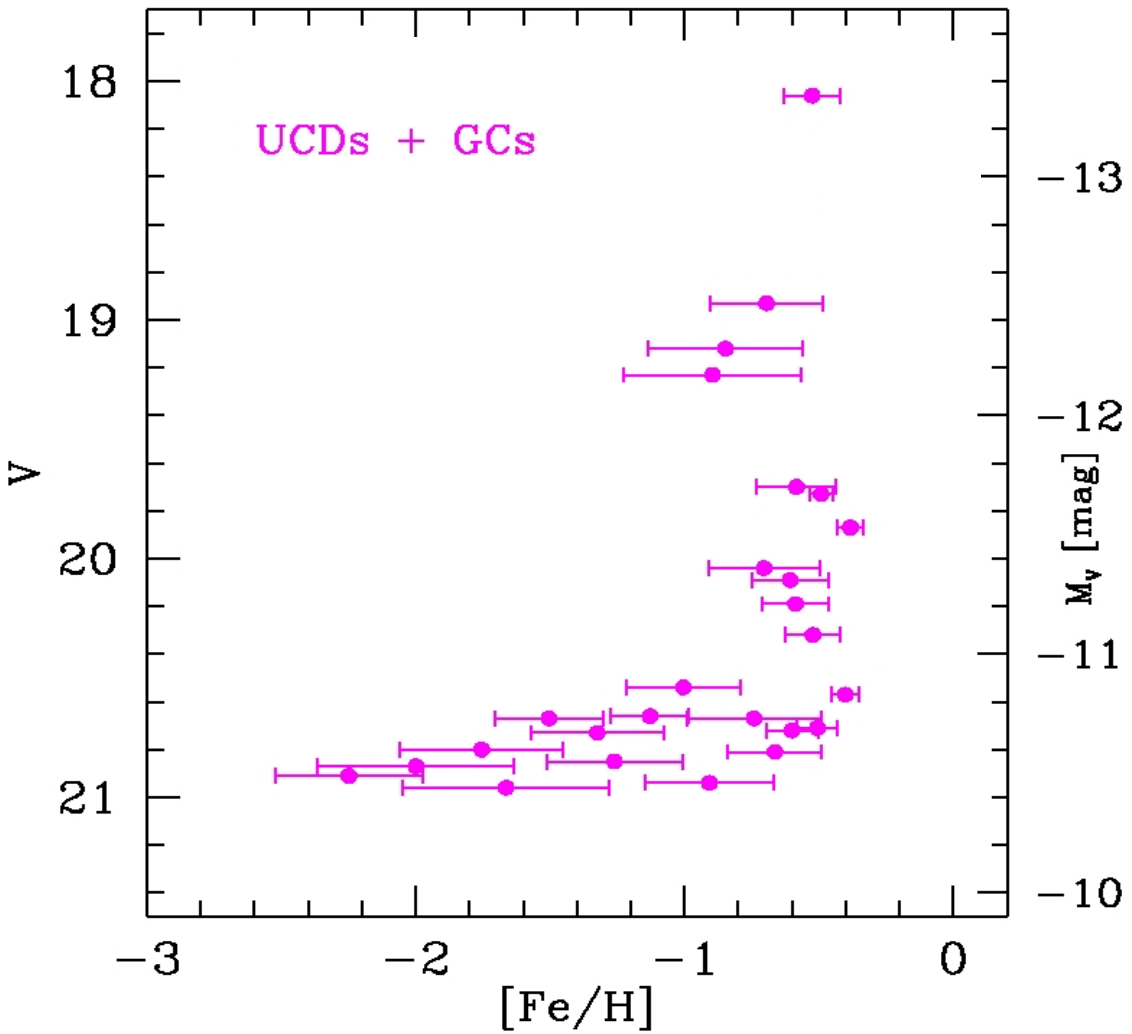
Hasegan et al. (2005)

High resolution photometry + spectroscopy:
UCDs beyond extreme end of GC mass-light-size space.

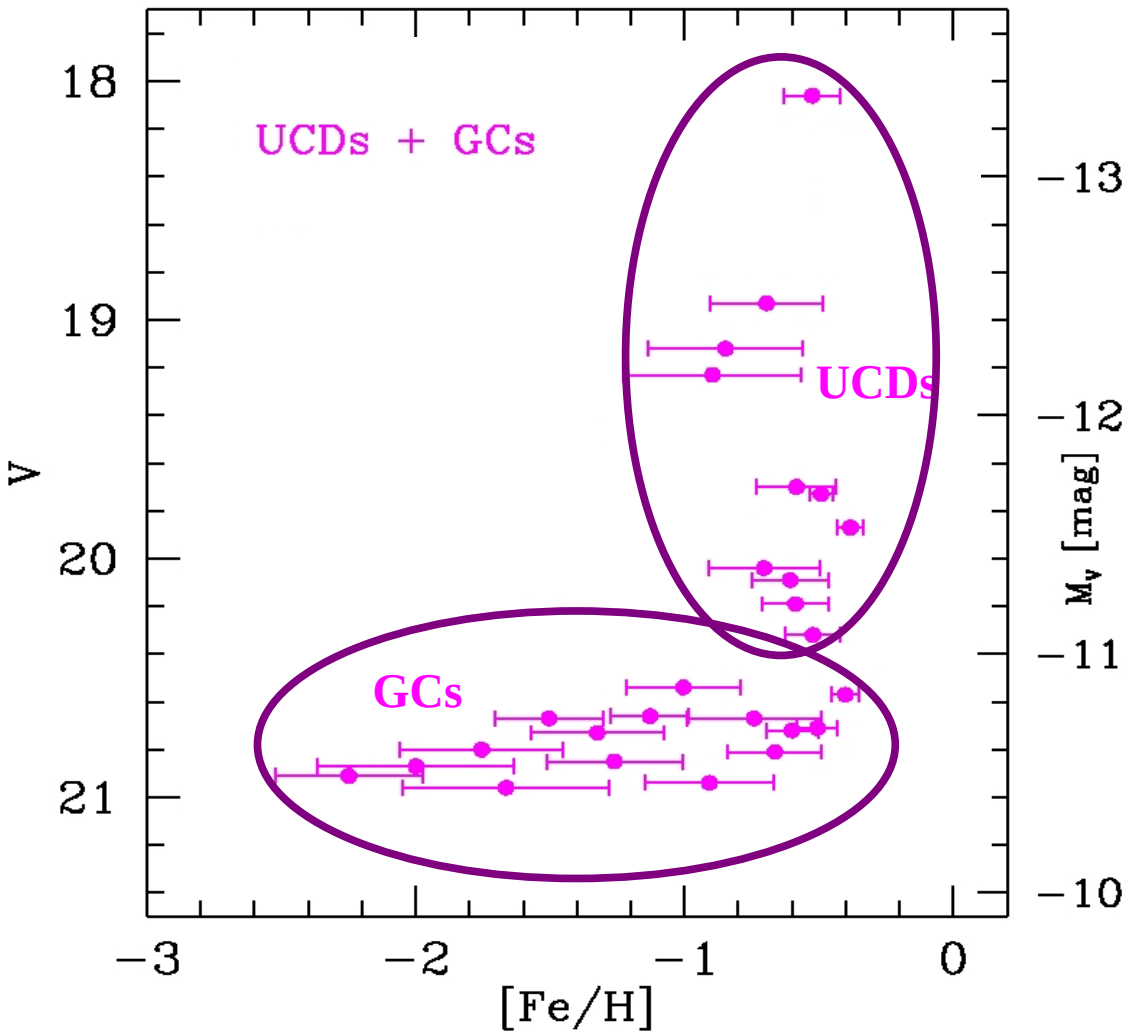


Sizes of Virgo UCDs

Hasegan et al. (2005)



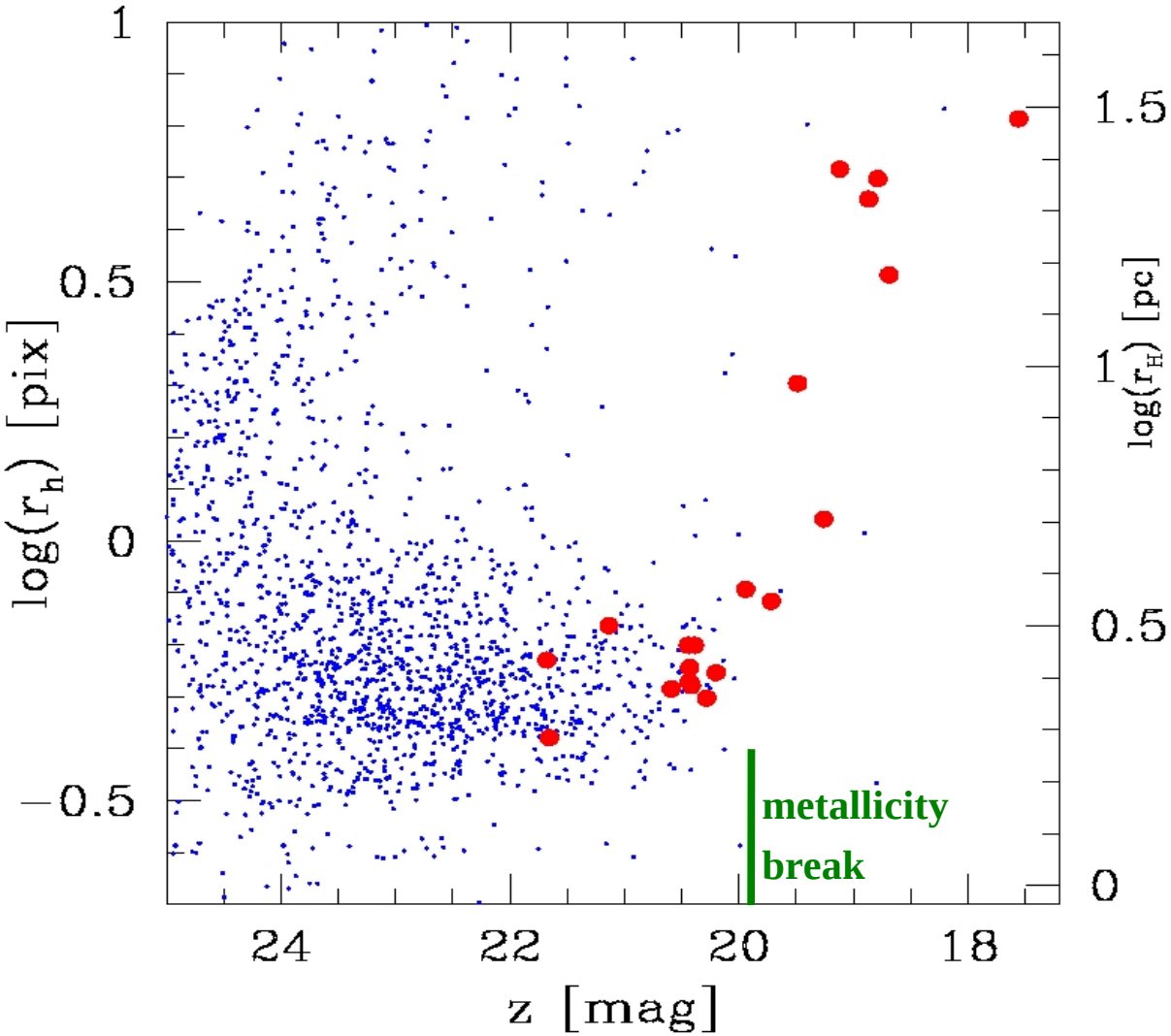
Metallicities of Fornax compact objects (Mieske et al. 2005)



Metallicities of Fornax compact objects (Mieske et al. 2005)

3.7σ metallicity break at M_V~-11 mag ($3*10^6 M_{sun}$)

→ Interpret as limit between UCDs (M_V<-11 mag) and GCs (M_V>-11 mag)



HST-sizes of Fornax UCDs/GCs (Drinkwater et al. 2003, Mieske et al. 2005, Jordan et al. 2006)

Metallicity break coincides with upturn in size distribution.

Confirm limit between GCs and UCDs @ $3*10^6$ M_{sun} (M_V=-11 mag)

Conclusions for Fornax/Virgo UCDs:

Fornax UCDs:	Virgo UCDs:
- larger than GCs - redder than nuclei - moderately metal rich (~YMCs) - M/L between 2 and 4	- larger than GCs - colour comparable to nuclei - metal poor (~nuclei) - M/L up to 9
↓	↓
faded YMCs	**nuclei**

Fornax cluster ~ 30 times higher current merger rate than Virgo.
Favours creation of YMCs in violent galaxy mergers.
Virgo cluster several times more massive than Fornax.
Favours tidal stripping of dE,Ns.

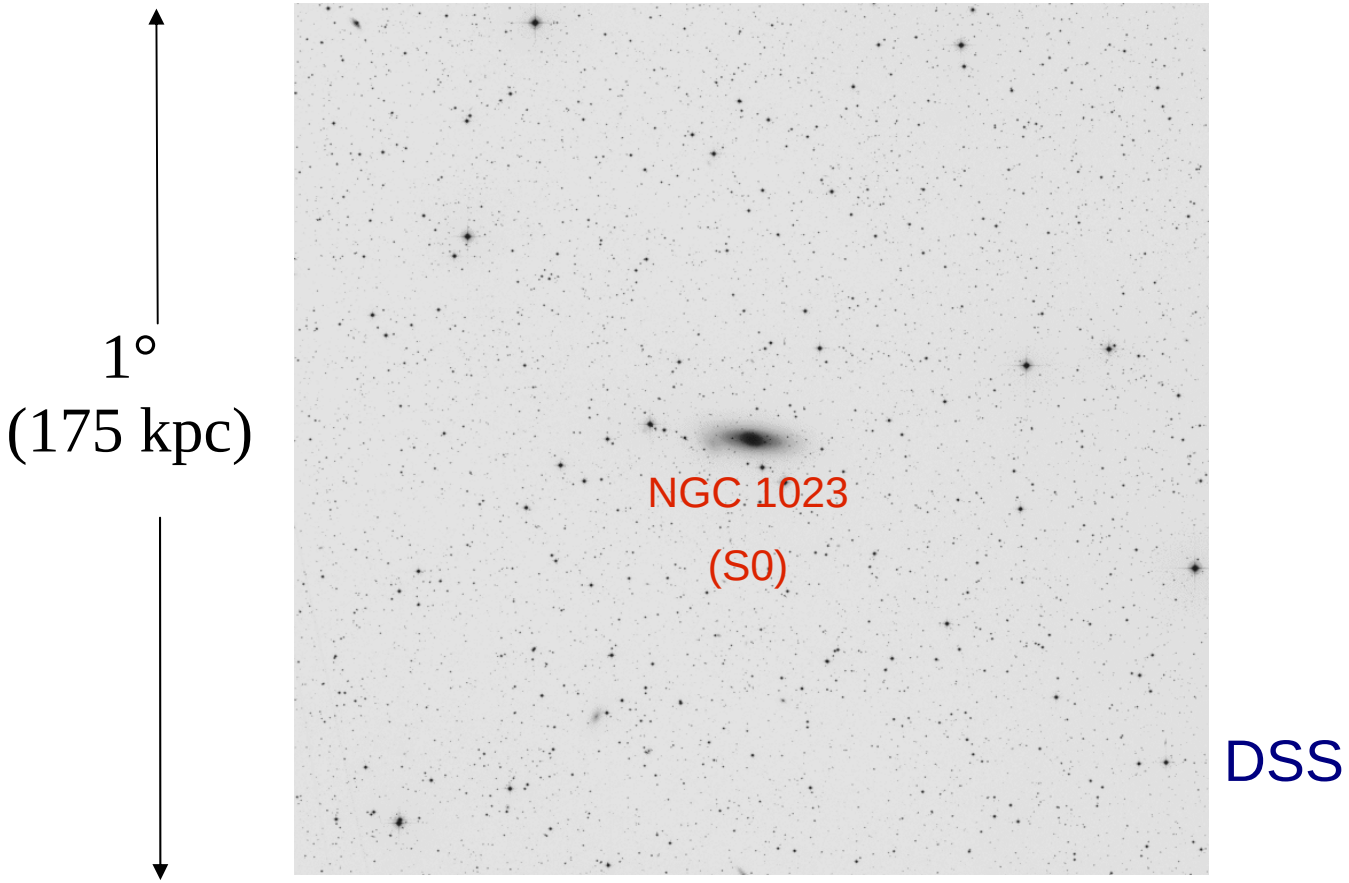
Global properties of Fornax and Virgo consistent with different formation channels deduced from UCD properties

→ ***Supports existence of two competing formation channels***

2. A search for UCDs in the NGC 1023 group

Are there any UCDs in group environments, and if so, what are their properties?

First target: NGC 1023 galaxy group at d~10 Mpc. Galaxy surface density 10 times lower than Virgo, 500 times less massive than Virgo. Velocity dispersion σ~60 km s^{-1}. "Fishing expedition".

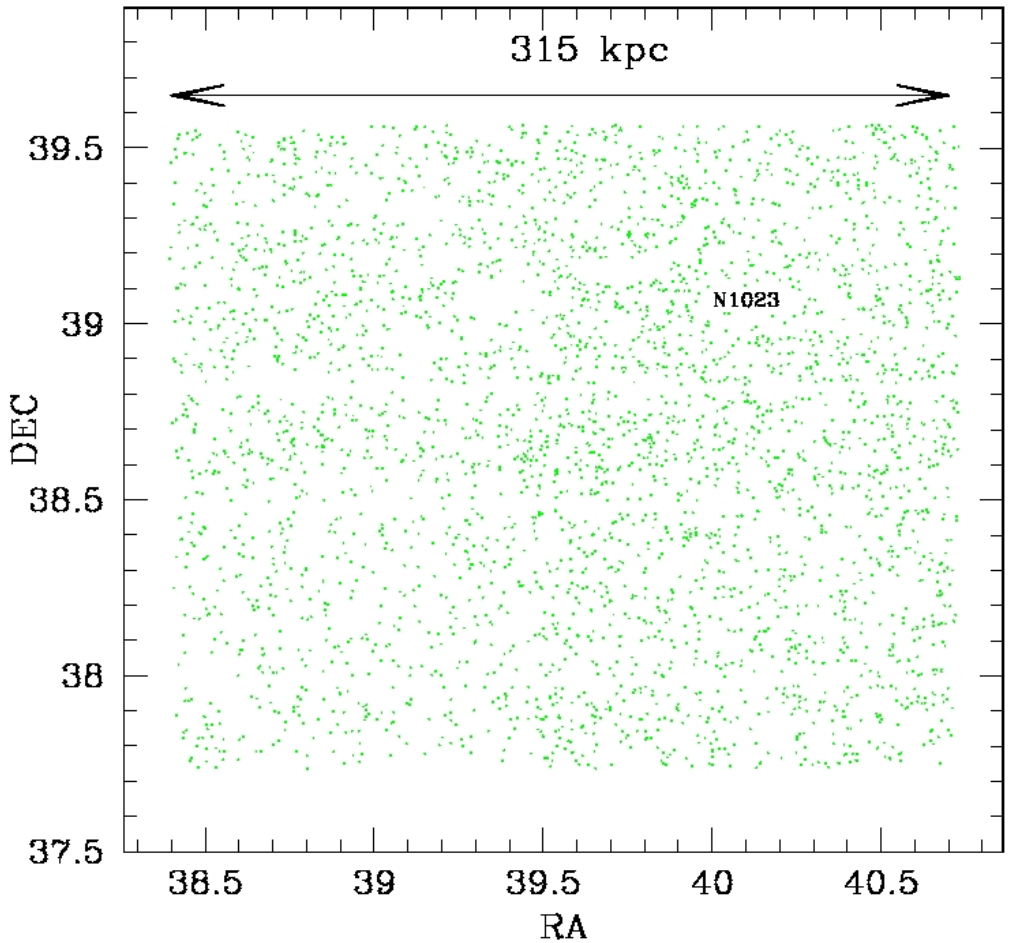


2. A search for UCDs in the NGC 1023 group

Since we're lazy and N1023 will (if at all) only host a few UCDs, make UCD search as efficient as possible. Try to avoid spectroscopy alap.

For photometric pre-selection use existing wide-field CFHT images of N1023 group obtained with OmegaCam (PI M. West). *Original aim: faint end of galaxy luminosity function.*

Dots are objects in range of Fornax-Virgo UCDs: 16<i<18.75 mag, with red colour cut applied
Huge contamination by foreground stars!!
(large FOV, low gal. latitude)



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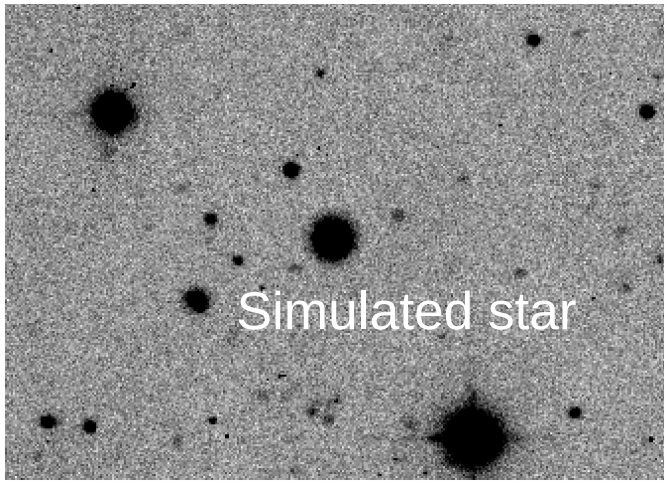
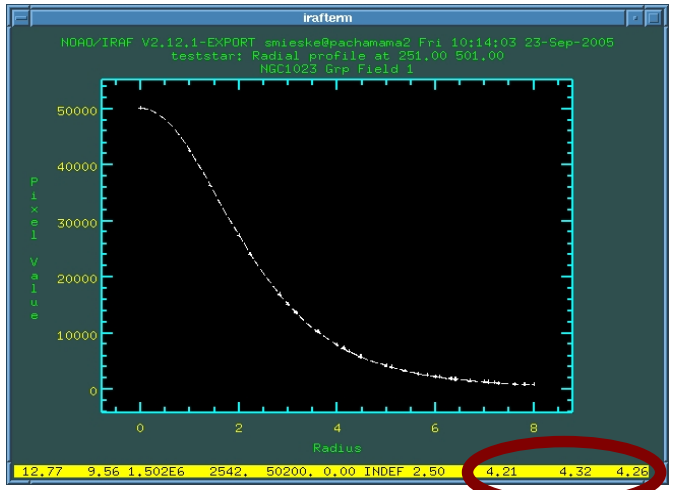
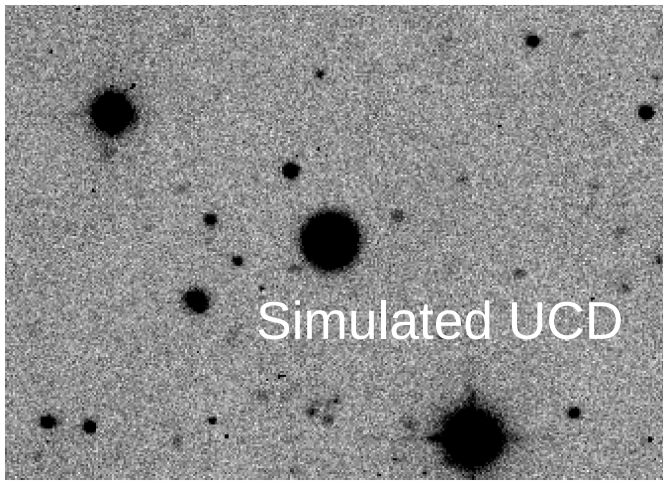
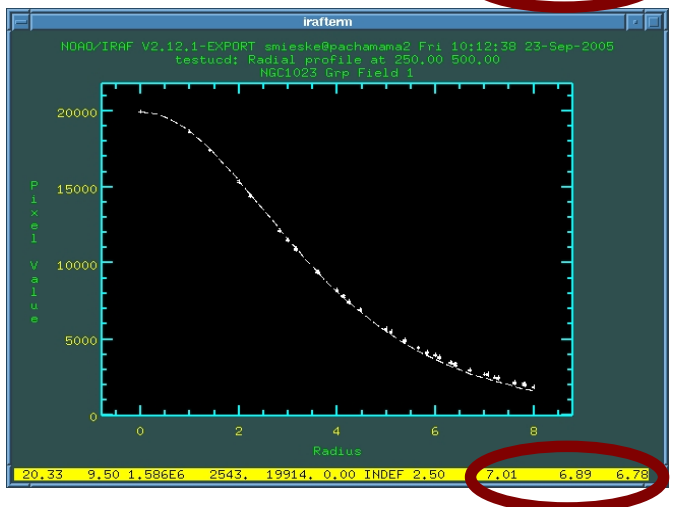




FWHM=0.8“





FWHM=1.3“

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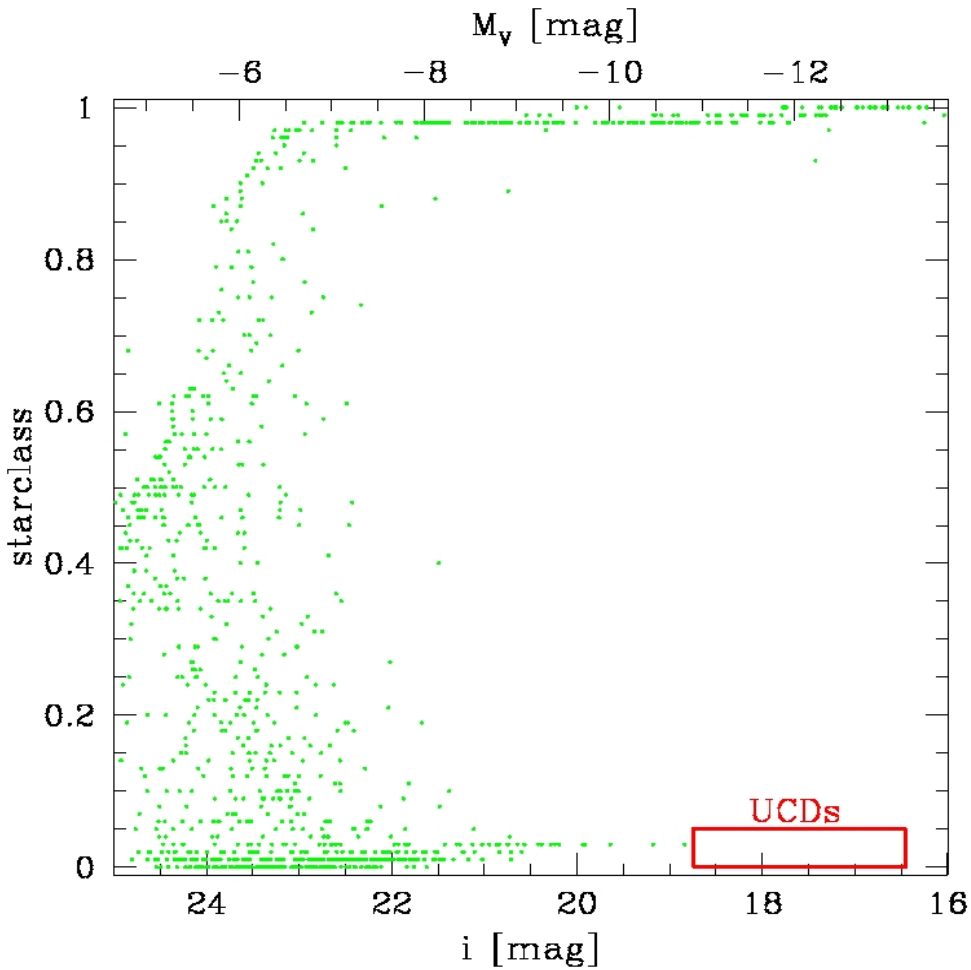
SExtractor will classify UCDs as galaxies, not stars!

Example: SExtractor star-classifier vs. magnitude for one out of 4*36=144 chips.

--> Very efficient selection of UCD candidates from starclass+luminosity



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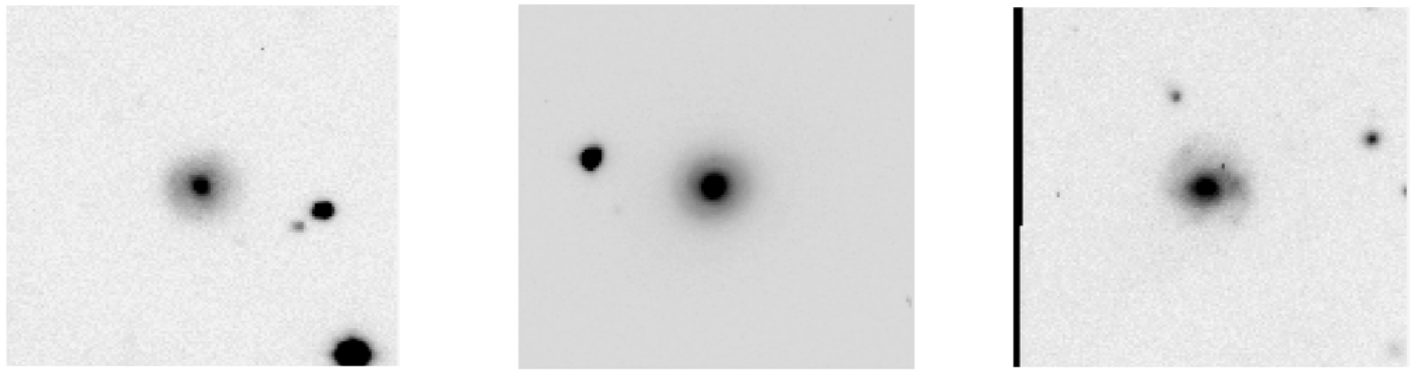
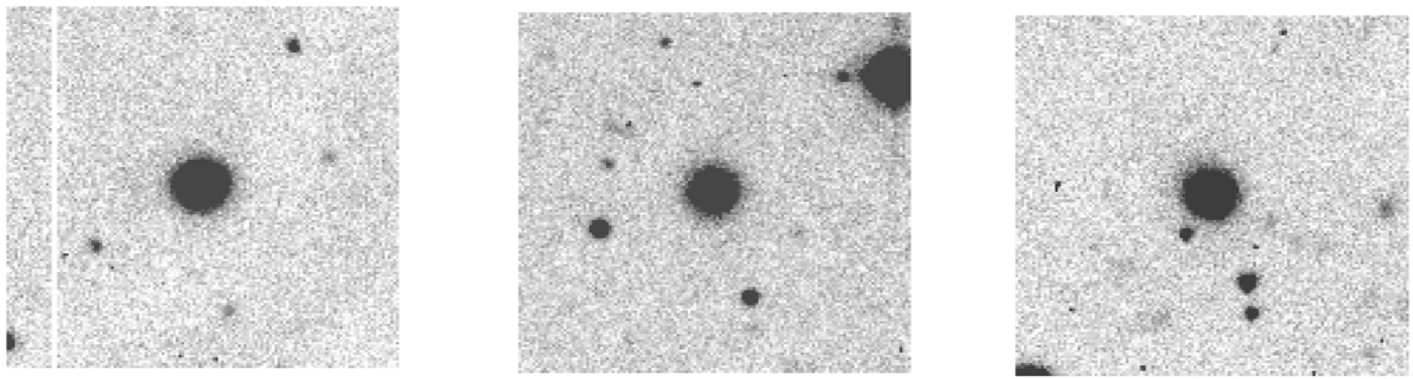
After colour-magnitude-starclass selection, final criterion is morphology:

Reject:



Accept:



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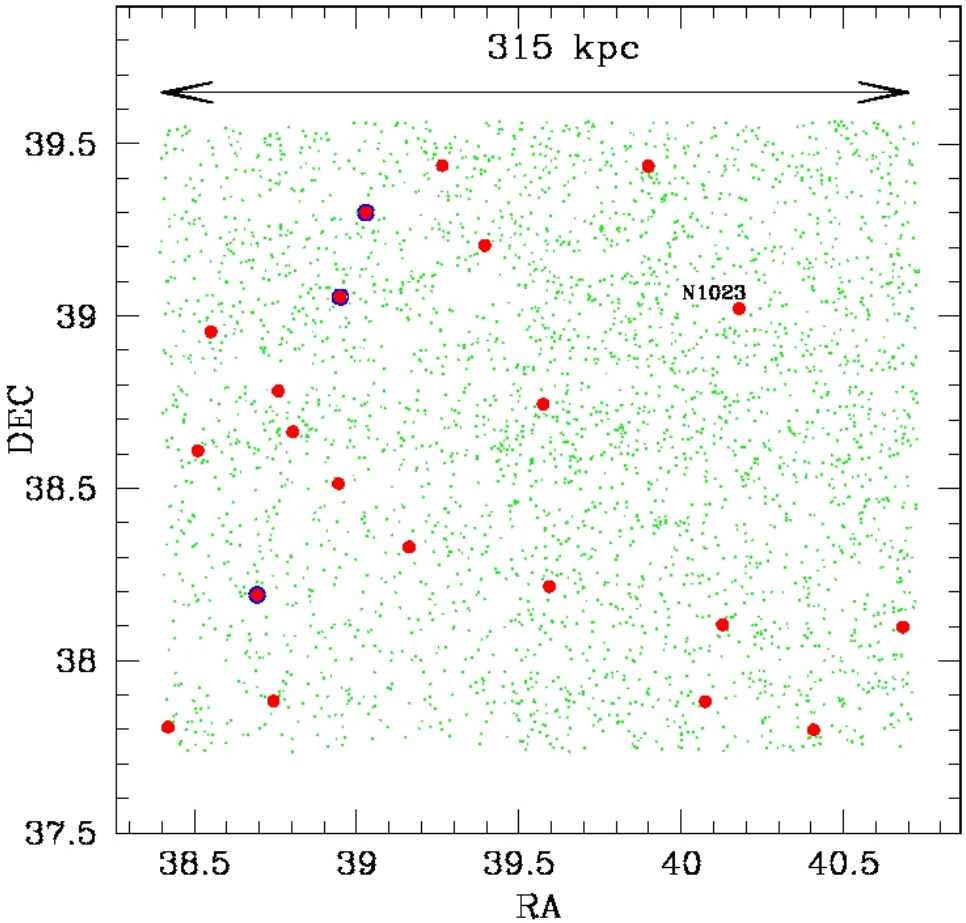
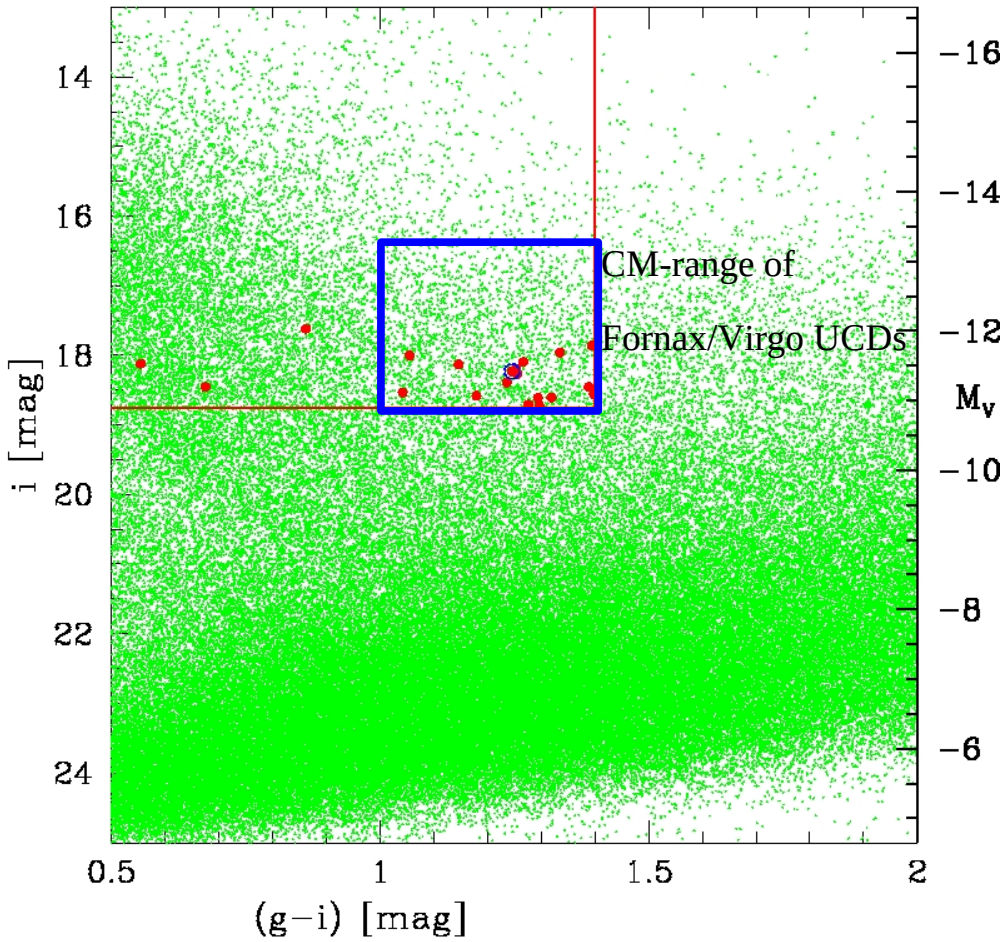
Final search result: 21 UCD candidates with $-12<M_V<-11$ mag, $10<r_h<30$ pc
No UCDs with $M_V<-12$ mag (10^7 M_{sun}). 5 times less massive than in Fornax/Virgo!





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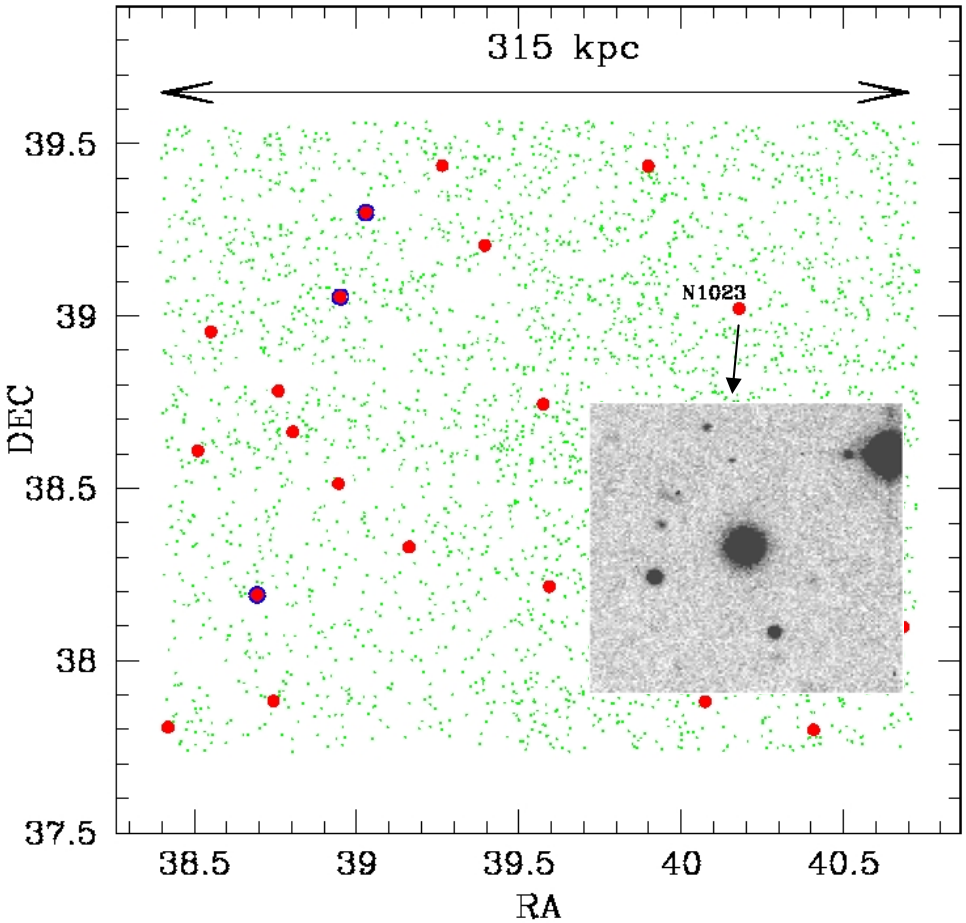

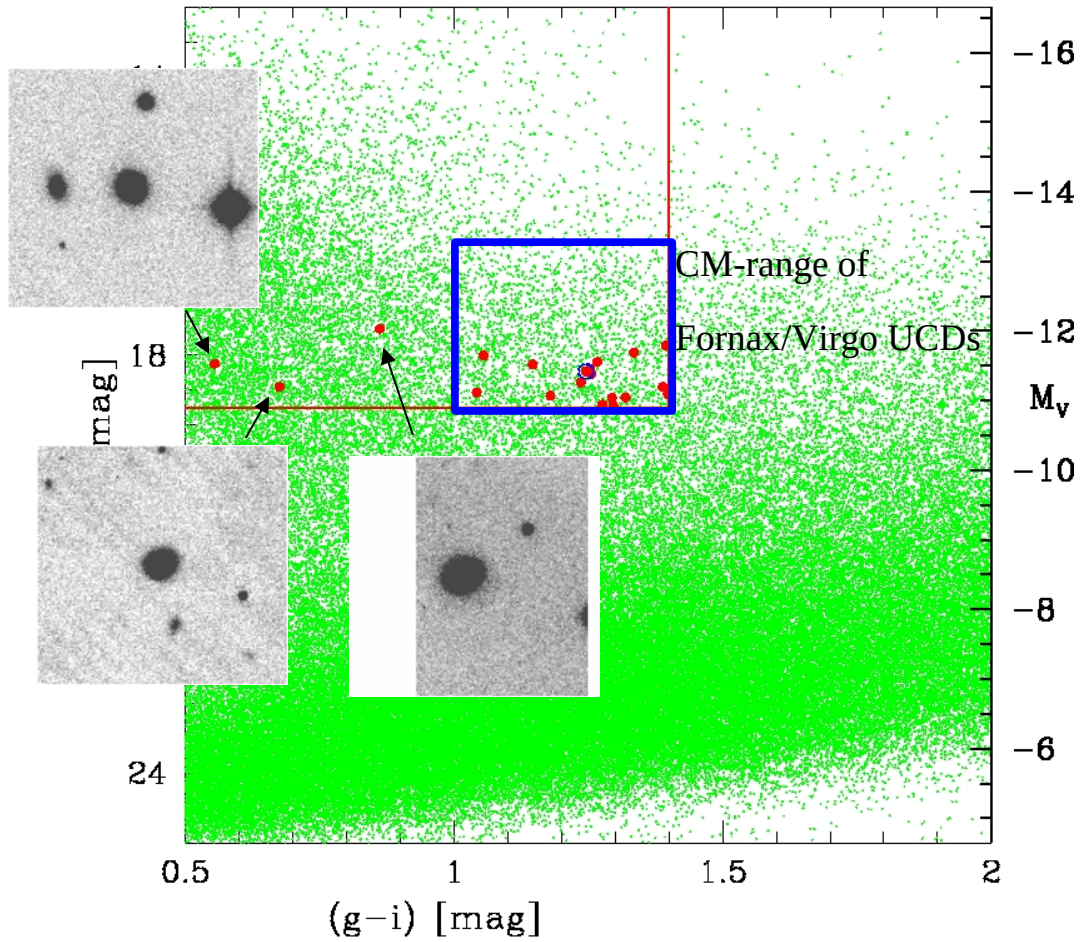

2. A search for UCDs in the NGC 1023 group

Conclusions:

1. Masses of UCDs in NGC 1023 group at least 5 times lower than in Fornax and Virgo clusters.

2. Colours of most UCD candidates consistent with old stellar populations

3. Uniform spatial distribution of UCD candidates. Consistent with significant background contamination.

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2. Colours of most UCD candidates consistent with old stellar populations

3. Uniform spatial distribution of UCD candidates. Consistent with significant background contamination.

4. **Spectroscopic cluster memberships needed!**

--> **To anyone who'd like to join the UCD business:**
If you observe within the next three months in the northern hemisphere and have some time left for simple longslit spectroscopy, please contact us :-).

smieske@eso.org

The End

Summary

1. Fornax UCDs: metallicity break at M_V~-11 mag is accompanied by upturn in size distribution
   --> M_V=-11 mag or ~ $3*10^6$ M_{sun} separates Fornax GCs from UCDs.

2. Different colours, metallicities and M/L ratios between Fornax and Virgo UCDs hint at different dominant formation channels:
   Fornax UCDs=Faded YMCs
   Virgo UCDs=stripped nuclei

3. Massive UCD candidates (10^7-10^9) found in massive cluster A1689.
   No UCDs found in loose group N1023.
   --> Number/mass of UCDs scales with host cluster mass

2. A search for UCDs in the NGC 1023 group

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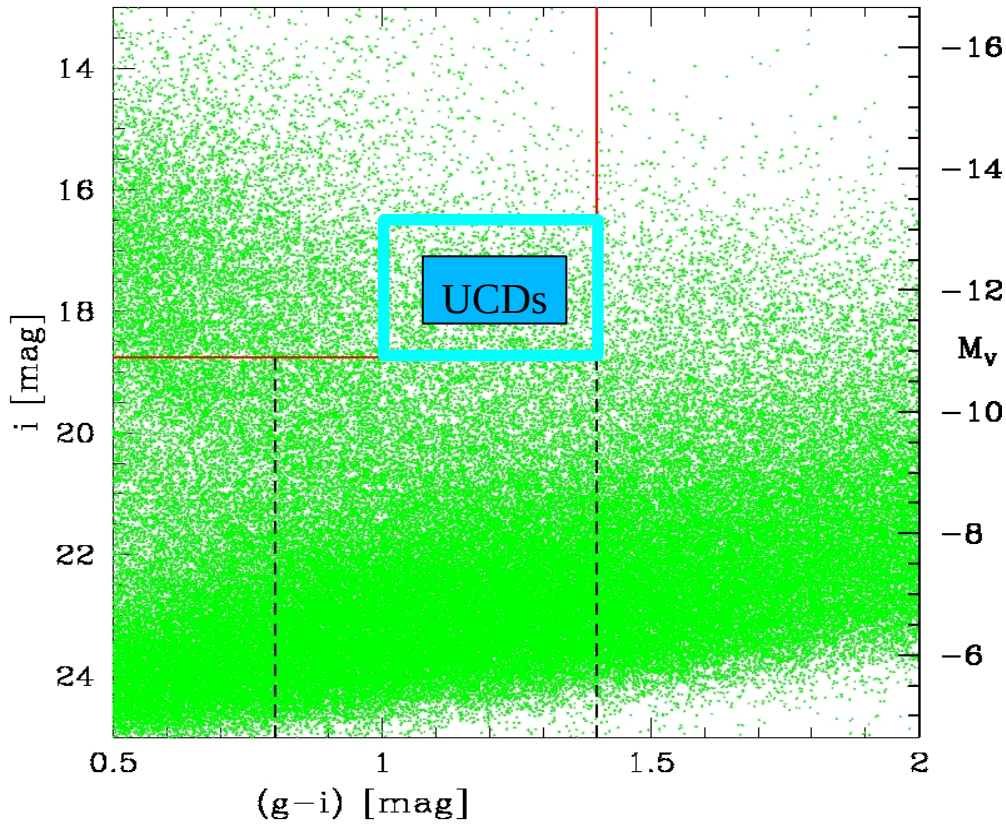
Favourable conditions: typical Fornax/Virgo UCDs have King core radii ~15pc. At N1023 distance of 10 Mpc they would be resolved!

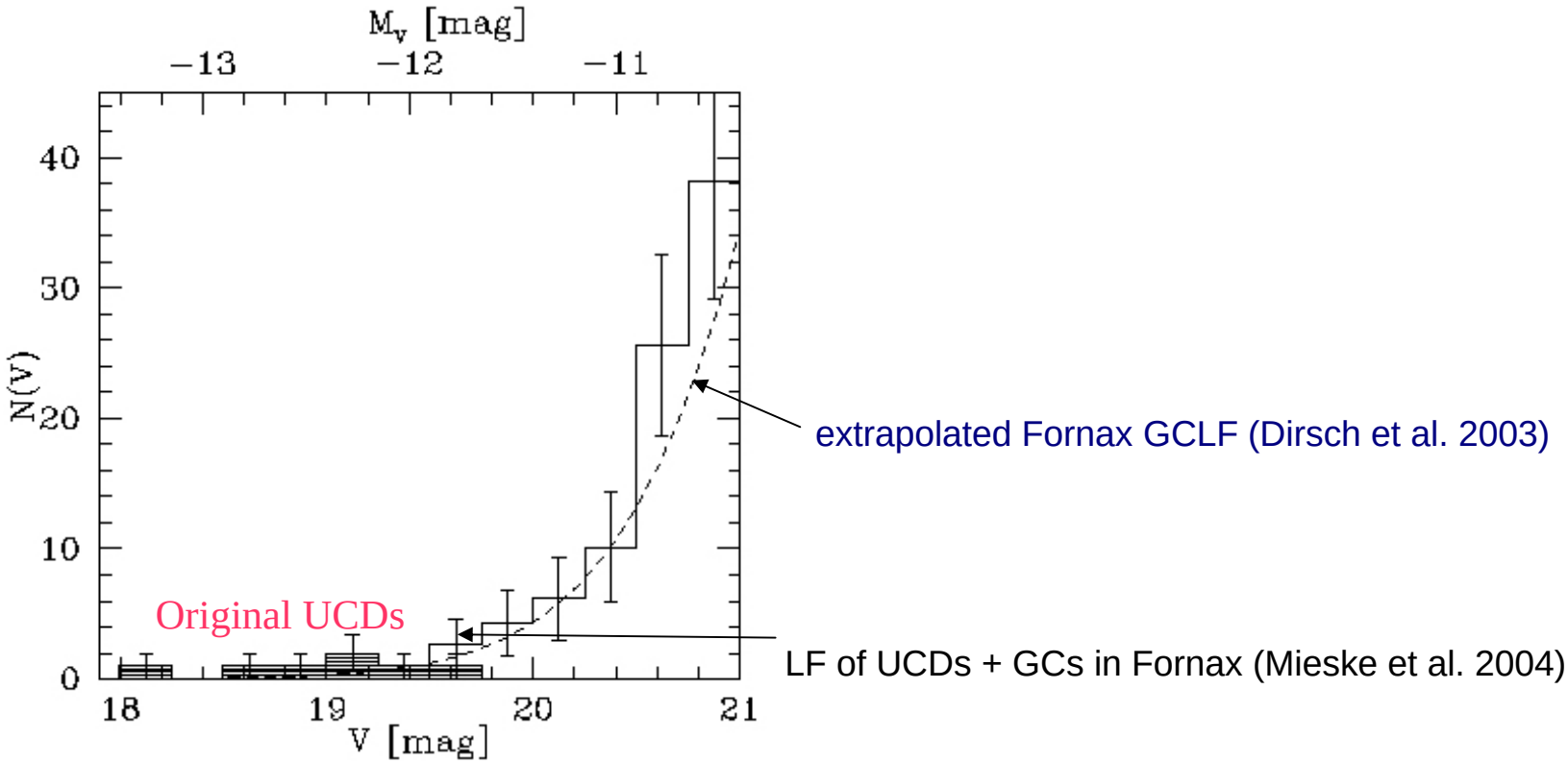
Use wide-field CFHT images of N1023 group obtained with OmegaCam:
(PI M. West)

Colour-magnitude selection of UCDs:



Possible origins of UCDs:

1. Brightest globular clusters (LFs overlap)



2. Stellar super-clusters created in mergers.
Young massive clusters as UCD progenitors?

(Fellhauer & Kroupa 2002, 2005, Kissler-Patig et al. 2005)

3. Stripped nuclei of dE,Ns (like ωCen?)

(Bekki et al. 2003)

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No UCDs with $M_V<-12$ mag. (Fornax/Virgo UCDs $-13.4<M_V<-11$ mag)

~50% of N1023 UCD candidates have sizes consistent with Fornax UCDs.