Ultra Compact Galaxies in Fornax
S-PLUS as a discovery machine

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UCDs in Fornax

- search for *ultra compact dwarfs* (UCDs) in Fornax

- difficult to identify: stellar morphology!

- but Fornax is special:

- Drinkwatter+2000: Fornax Cluster Spectroscopic Survey – spectroscopic survey of everything in $16.5 < bj < 19.7$

- Mieski+2002: Fornax Compact Object Survey

- *S-PLUS: gain in area & photometric depth*

- *search for new UCD candidates*

- How do they form?
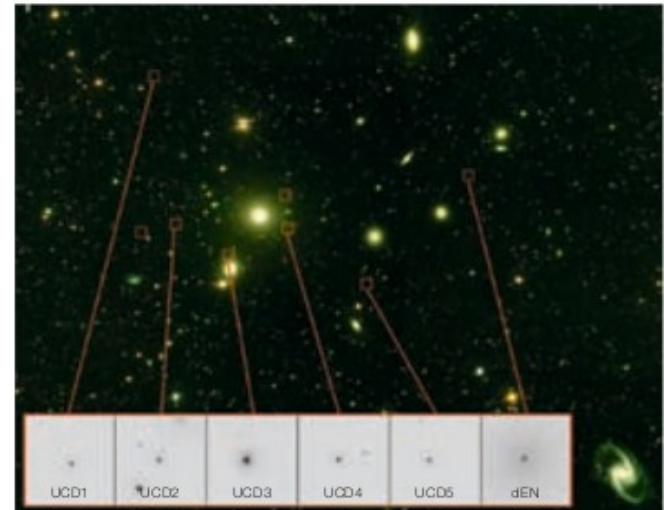- Remnant nuclei of stripped galaxies?
- Merged stellar superclusters?
- Low luminosity version of bright galaxies?

- Properties?
- Stellar populations?
- Super-massive BHs?
- Minimum mass?

- **data: iDR3_23Fields_Fornax_galaxies**

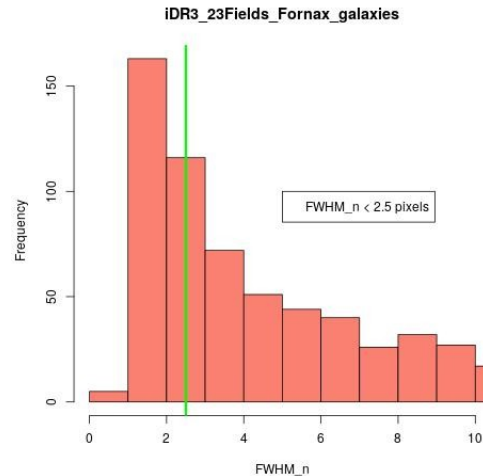 **711 galaxies (CLASS_STAR < 0.3)**

- **candidates to ultra compact galaxies:**

- **14 < Rpetro < 20.5; FWHM_n < 2.5 pixels**

  (to include Fornax known UCDs)

- **Mg < -11   (M$_*$ ~ 10^6 Msun)**

  (to 'avoid' globular clusters, Mieske+2006)
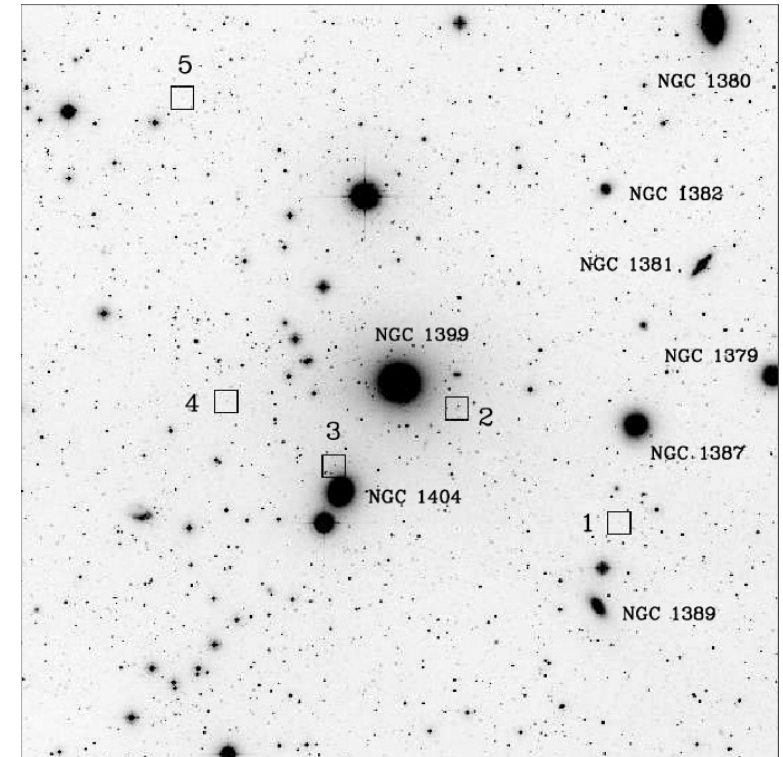
- **magnitudes in 12 bands**

- **results:**

- **FWHM_n < 2.5 pixels: 212 objects, 48 with cz, 119 with magnitudes in 12 bands**

- **+ Mg: 96 objects**

- **cleaning: 85 UCDs, 16 with cz**

iDR3_23Fields_Fornax_galaxies

FWHM_n < 2.5 pixels

iDR3.SPLUS-s28s32.006199
RA: 51.5035368269767
DEC: -36.7946360235193
brightest MU_MAX

iDR3.SPLUS-s27s35.022130
RA: 56.3904595100055
DEC: -34.9794708001861
reddest (r-i)

iDR3.SPLUS-s28s33.045255
RA: 52.9712243722767
DEC: -35.5757014038094
reddest (g-r)

iDR3.SPLUS-s27s34.006599
RA: 54.168855951012
DEC: -35.368383362235
bluest (r-F660)

iDR3.SPLUS-s28s34.039475
RA: 54.2725105827537
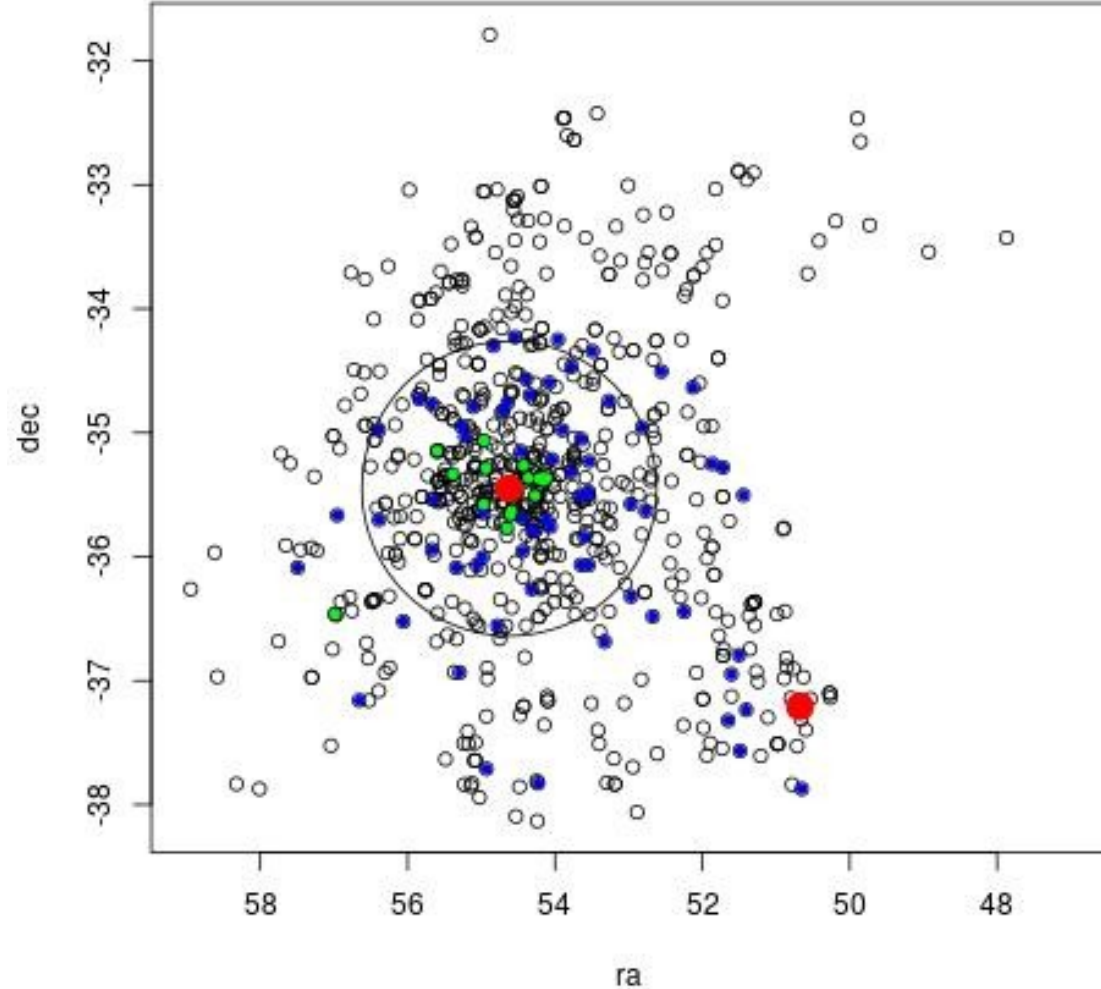DEC: -35.795397011232
faintest SBr

iDR3.SPLUS-s29s34.059206
RA: 56.6565977403894
DEC: -37.1594152061848
largest ref = dE,N
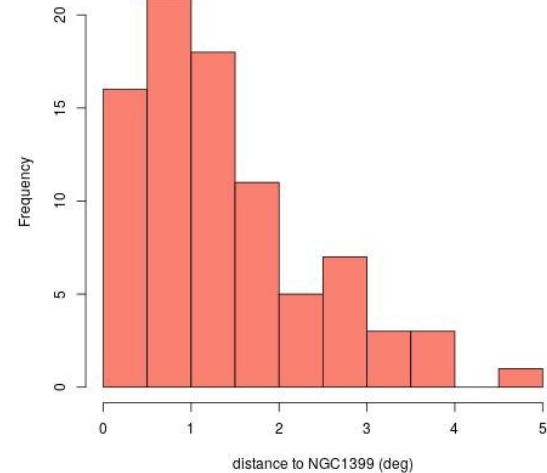
iDR3.SPLUS-s28s36.005584
RA: 57.7537158222249
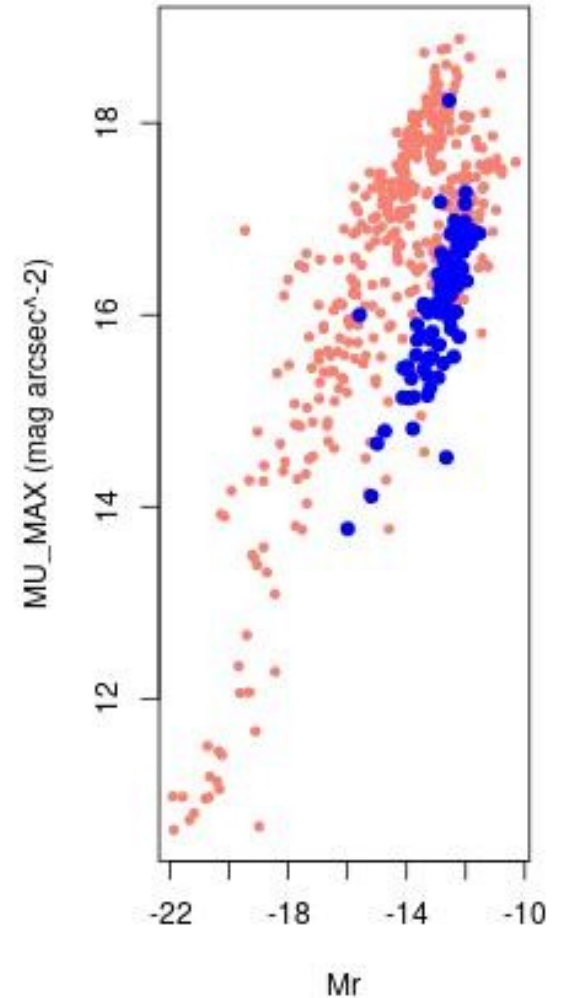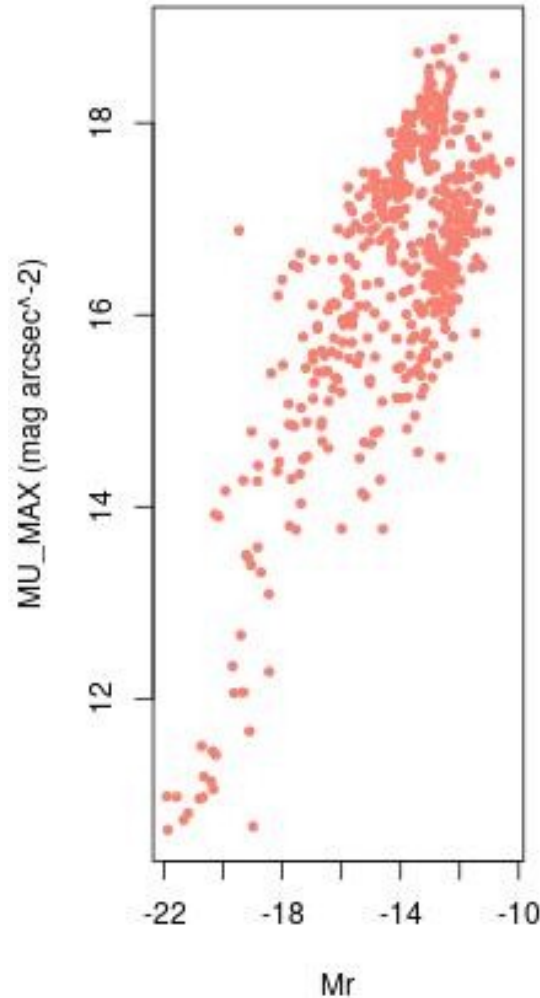DEC: -36.6825265840059
ultra diffuse dwarf

distribution:

- extended

- centrally concentrated:

  $\langle r \rangle \sim 0.7\ r_{vir}$

- many galaxies beyond r_{vir}

- two populations of dwarfs wrt MU_MAX:

  diffuse & compact

  disk & spheroid

- UCD candidates are in the compact branch

- also many not so compact in this branch (e.g., dE,N)

SMBH in UCDs?

- **UCD3 – $M_{BH} \sim 10^6\ M_{sun}$ (Afanasiev+ 2018)**

- **photometric candidates:**

  Kaviraj+ (2019): w_1-w_2 > 0.52

  17 UCDs! 7 with Galex photometry

- **there is not a significant difference between ordinary UCDs and those which may contain an AGN**
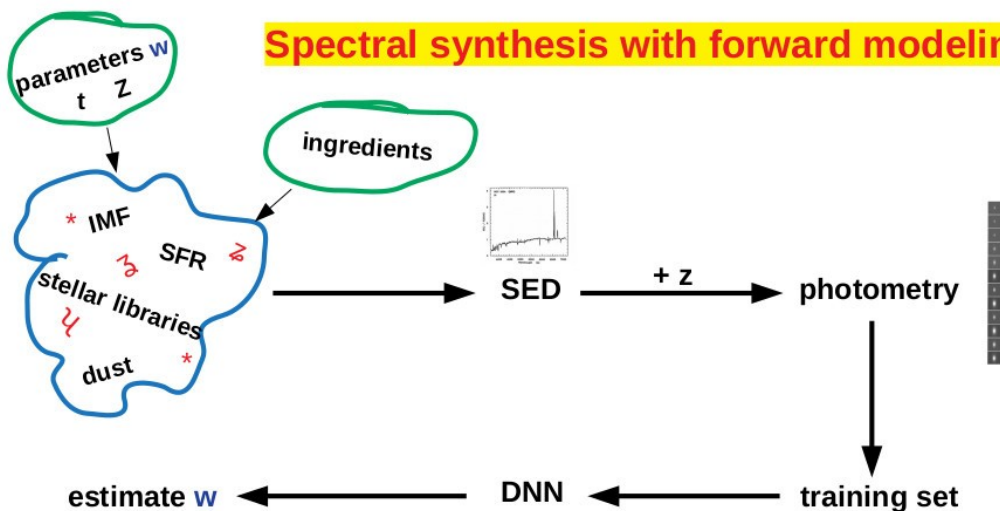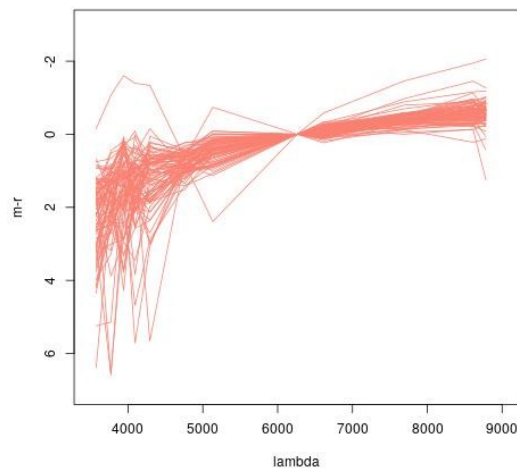
- *unexplored intermediate/low mass BHs regime!*
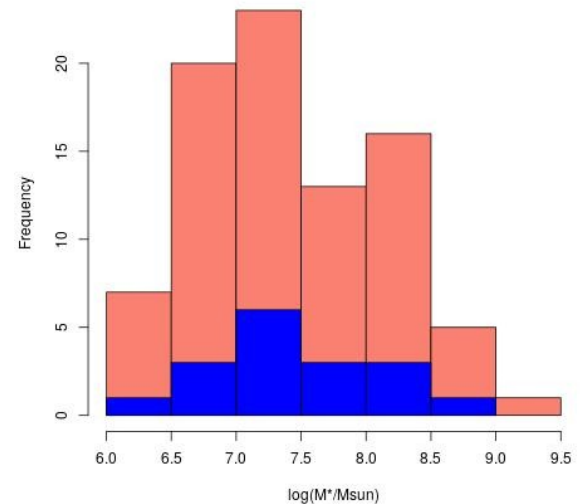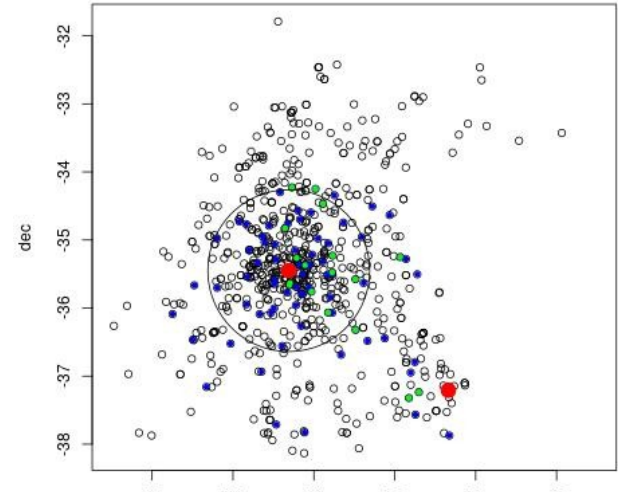
lazy starlight

stellar population parameters through machine learning

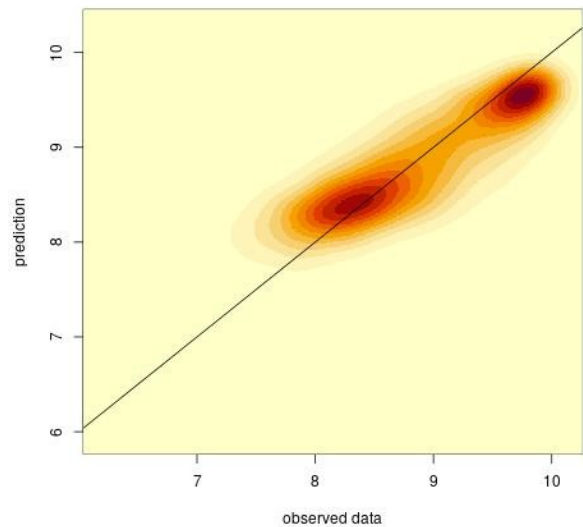**Spectral synthesis with forward modeling**
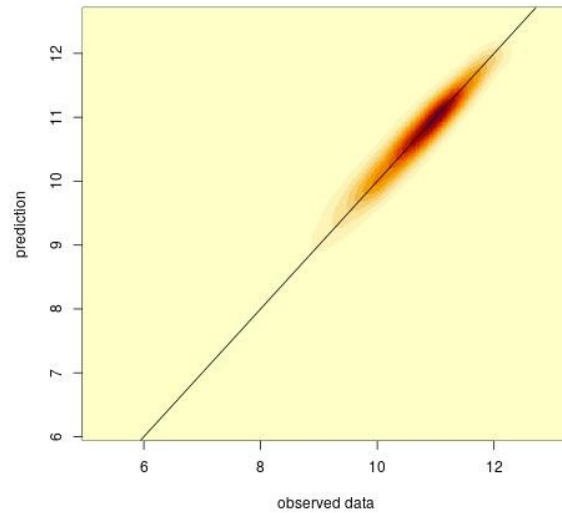

UCD photo-spectra

- **Deep neural network trained to reproduce Starlight population synthesis from S-PLUS photometry + specz**

- **output: parameters of the stellar populations:**

  T_l, T_m, Z_l, Z_m, A_v, M_*, EW(Hα)

- **Training set: S82 – 48696 galaxies**

- **Application to Fornax, assuming all galaxies at z = 0.005**
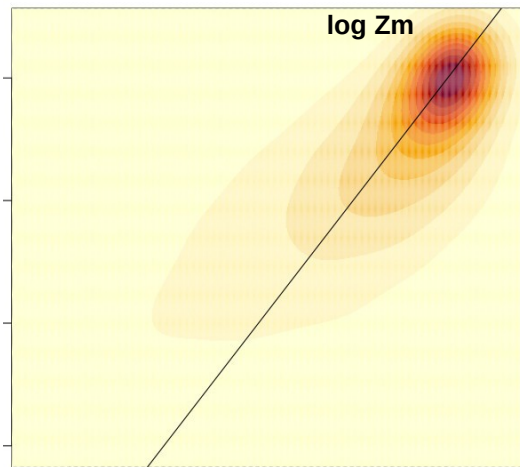
log TI
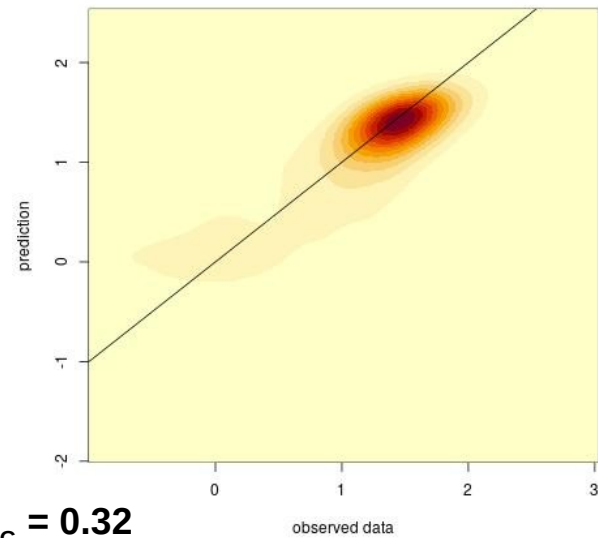
$\sigma_G = 0.39$

log Mstar

$\sigma_G = 0.18$

log Zm

$\sigma_G = 0.26$

log EW(Halpha)

$\sigma_G = 0.32$

iDR3.SPLUS-s28s32.006199

RA: 51.5035368269767

DEC: -36.7946360235193

smallest TI and ZI, max EWHa

iDR3.SPLUS-s27s33.023894

RA: 52.815666580925

DEC: -34.9570080928101

largest TI

iDR3.SPLUS-s27s35.022130
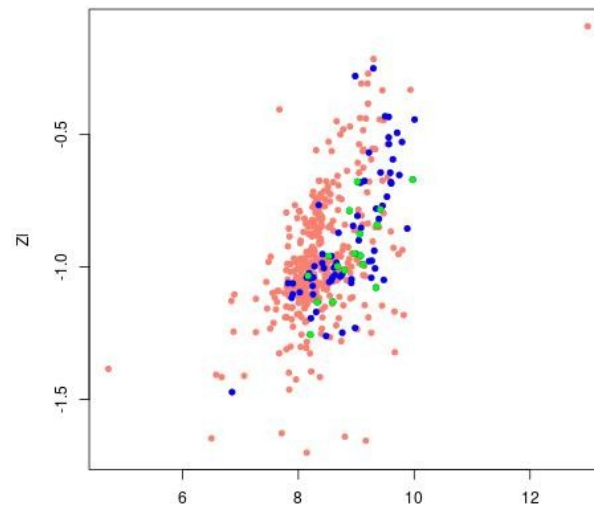
RA: 56.3904595100055

DEC: -34.9794708001861

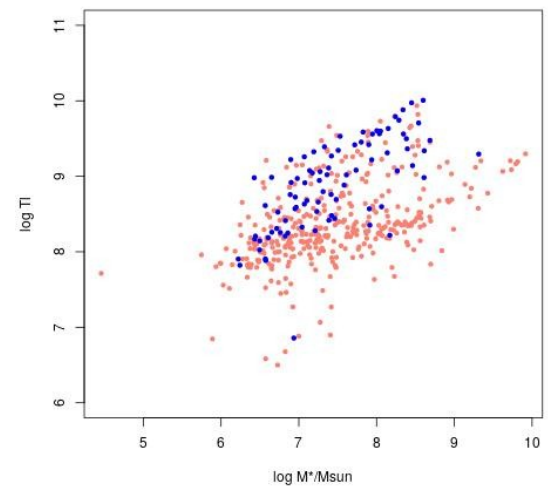**largest ZI and M***

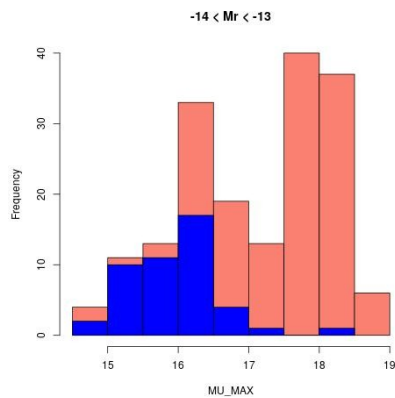iDR3.SPLUS-s29s31.019840

RA: 51.4890727649093

DEC: -37.566289464019

smallest M*

dwarfs x UCD

Fornax: -14 < Mr < 12.5
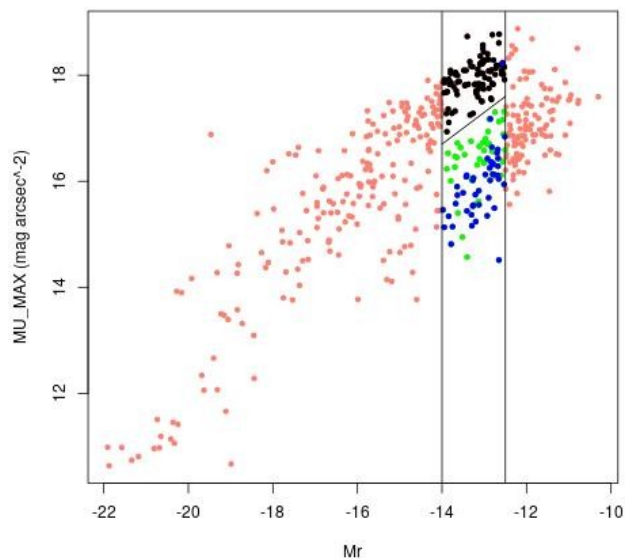
	D	C	UCD
$\log T_l/Gyr$	8.1 ± 0.4	8.8 ± 0.6	9.0 ± 0.6
$\log T_m/Gyr$	9.5 ± 0.3	9.8 ± 0.2	9.9 ± 0.2
$\log Z_l/Z_\odot$	-1.1 ± 0.1	-0.9 ± 0.2	-0.8 ± 0.2
$\log Z_m/Z_\odot$	-1.3 ± 0.1	-1.0 ± 0.3	-0.9 ± 0.2
A_V	0.2 ± 0.2	0.3 ± 0.3	0.4 ± 0.3
$\log M_*/M_\odot$	6.9 ± 0.5	7.4 ± 0.6	7.6 ± 0.7
$\log EW(H\alpha)/\mathring{A}$	1.5 ± 0.4	0.9 ± 0.6	0.8 ± 0.6
$M/L_r \ (M_\odot/L_{r\odot})$	0.7 ± 0.2	0.9 ± 0.4	1.0 ± 0.4

What we can infer on the nature of UCDs?

- **probably a mixed bag**

- **they can't be mostly stripped dE,N**

- **probably a different formation channel, similar to globular clusters? collapse/merger of star clusters?**

Trends:

- **C tend to be older, more metallic, more massive, with less star-formation than D**

- **UCDs are a bit more extreme than C's**

- **Correlation of MU_MAX with stellar population parameters, given Mr**

summary

- **New sample of UCD candidates: > 85 objects**

- **17 with AGN wise-selected colors**

- **Improvements expected from new star/galaxy classification, spectral synthesis, photo-z's (?)**

- **Opportunity for follow-up: redshifts,..., IFU?**