SDSS search for galaxies like the of Blue Compact Dwarf host galaxies

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Summary

- **M**otivation
- **S**earch
- **R**esults
  - ✓ Colors and Surface Brightness
  - ✓ H_α equivalent width
  - ✓ O/H abundances
  - ✓ Luminosity Function(s)
- **F**uture prospects
- **C**onclusions

Motivation

Blue Compact Dwarf galaxies (BCDs) are metal poor systems undergoing vigorous star formation. Due to the strength of the starburst and smallness of the dwarf galaxy, this process can last only a few My, i.e., a small fraction of the galaxy lifetime (Gys).

Where are the galaxies before and after they glow as BCDs? It is so far unknown.

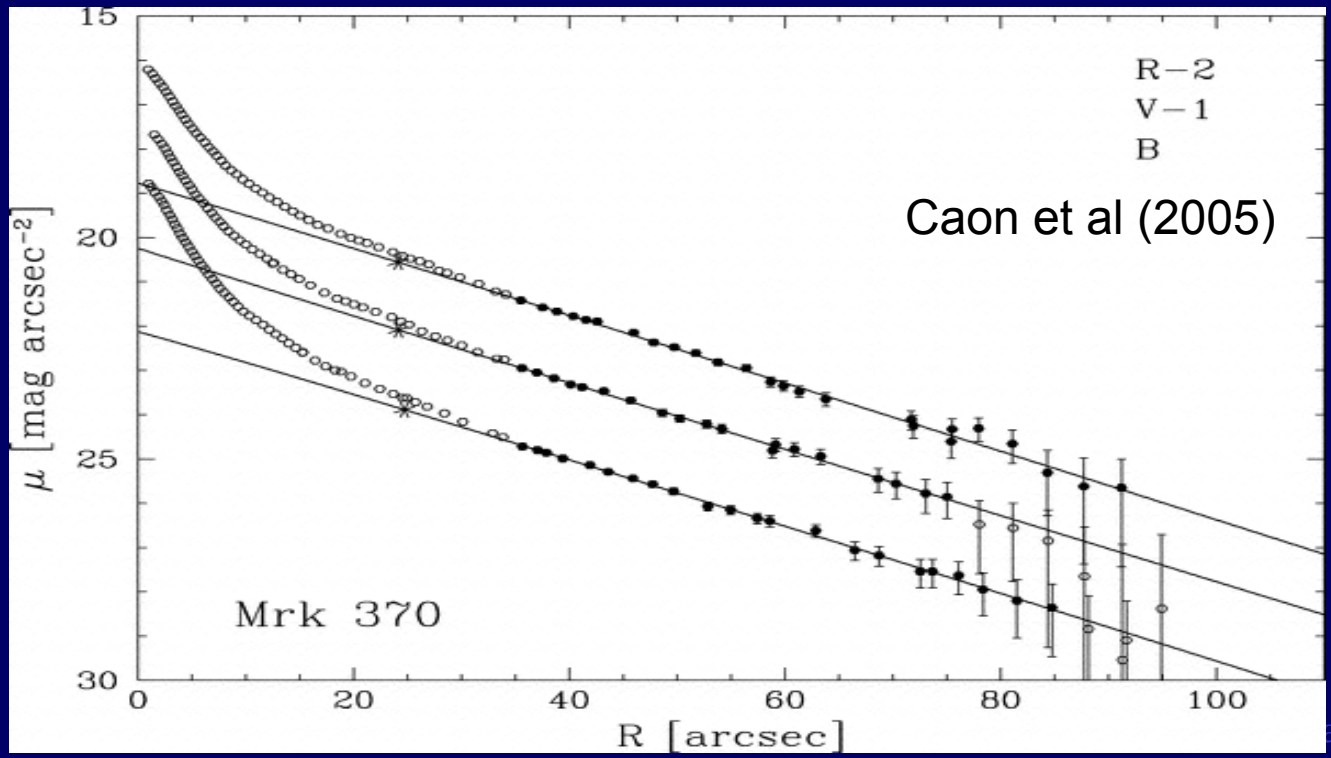
This work aims at identifying field galaxies which could be precursors and leftovers of the BCD phase.

Cosmological twist: BCDs seems to be young systems undergoing their first major starburst. Ideal for studies of cosmological implication (primordial abundances, galaxy formation in the universe, missing dwarf galaxy problem, triggering of star formation …)

The interest of the project should be framed within the more general issue of the missing dwarf galaxy problem. They are predicted in lots by the concordance cosmological model, but these pristine galaxies remain unobserved (see, e.g., Diemandet al., 2006).

Search

Most BCDs galaxies are known to have a red low surface brightness component (e.g., Kunth & Oslin 2000), which should exist before the starburst, and which probably survives the BCD phase.



We search for field galaxies with luminosities, surface brightness, and colors characteristic of the low surface brightness component (LSB) of the BCDs analyzed by Amorín (2005; et al., 2007).

Amorín et al. fit a Sersic profile to the outskirts of BCD images in various filters, masking the bright BCD core. They have a sample of 8 BCD galaxies

Search carried out in Sloan Digital Sky Survey Data Release 5 (Stoughton et al. 2002; Adelman-McCarthy et al. 2007)

SDSS/DR5 is unique:

- 5740 sq. deg. coverage of the spectroscopic catalog.
- More than 1000000 targets
- Spectroscopy from 3800 to 9200 AA with R=1800
- Complete for r < 17.77 mag

Search Criteria for BCD Host Galaxies:

(Johnsons mag → SDSS mag according to Smith et al. 2002;
Petrosian mag. → integrated mag. from)

1.- Absolute magnitude $-19 \leq M_g \leq -14$

2.- Colors $0.2 \leq g - r \leq 1.0$

3.- Sersic index (Ξ Surface Brightness; Graham et al 2005)

$$0.74 \leq n \leq 2.2 \equiv 2 \leq \mathrm{R}_{90} / R_{50} \leq 3$$

4.- Isolated (inspired by Allam et al. 2005); no companion brighter than 3 mag fainter than the candidate within $10\ \mathrm{R}_{50}$

5.- Others: redshift > 0.003 and $\mathrm{R}_{50} \geq 4\ \mathrm{arcsec}$

CASJOBS required!

5387 candidates

Search Criteria for BCD candidates:

Control sample to be compared with the LSB candidates

Criteria inspired by Malmberg(2005) and quantified according to Gil de Paz et al. (2003)

1.- Absolute magnitude $M_g > -19.12 + 1.72(M_g - M_r)$

2.- Blue Colors $\mu_g - \mu_r \leq 0.43$

3.- High Surface Brightness $\mu_g < 21.83 - 0.47(\mu_g - \mu_r)$

4.- High start formation rate $W_{H_\alpha} > 50$ Å

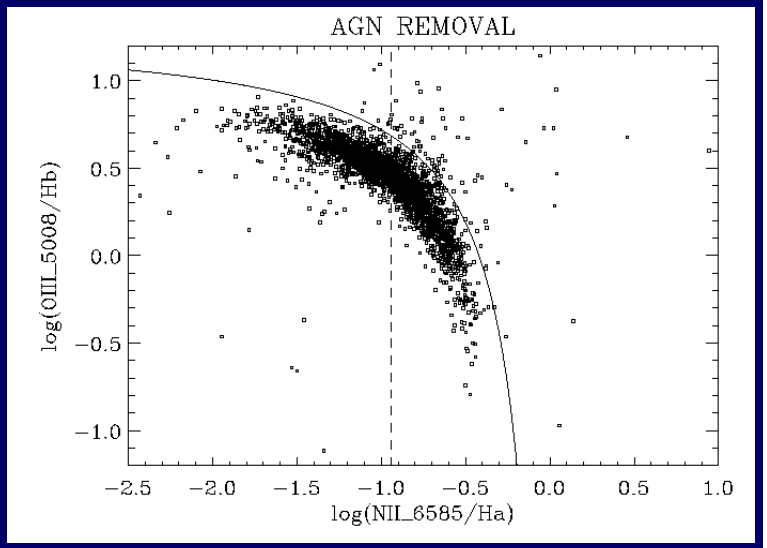
5.- Be metal poor

$$12 + \log(O/H) < 8.43 \ (\equiv 1/3 \, \text{solar O abundance})$$

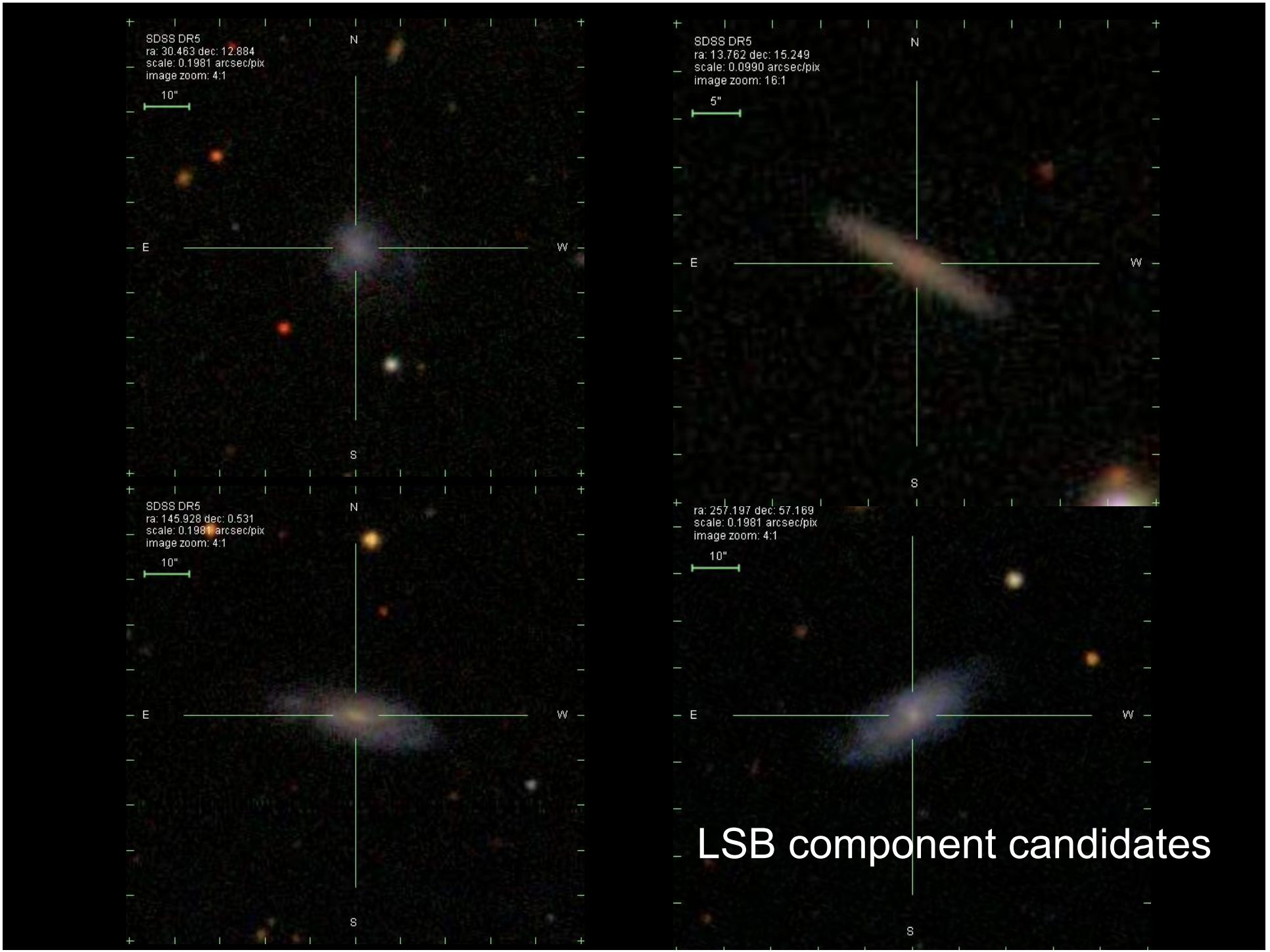
O/H computed using the so-called N2 index (e.g., Shi et al 2005)

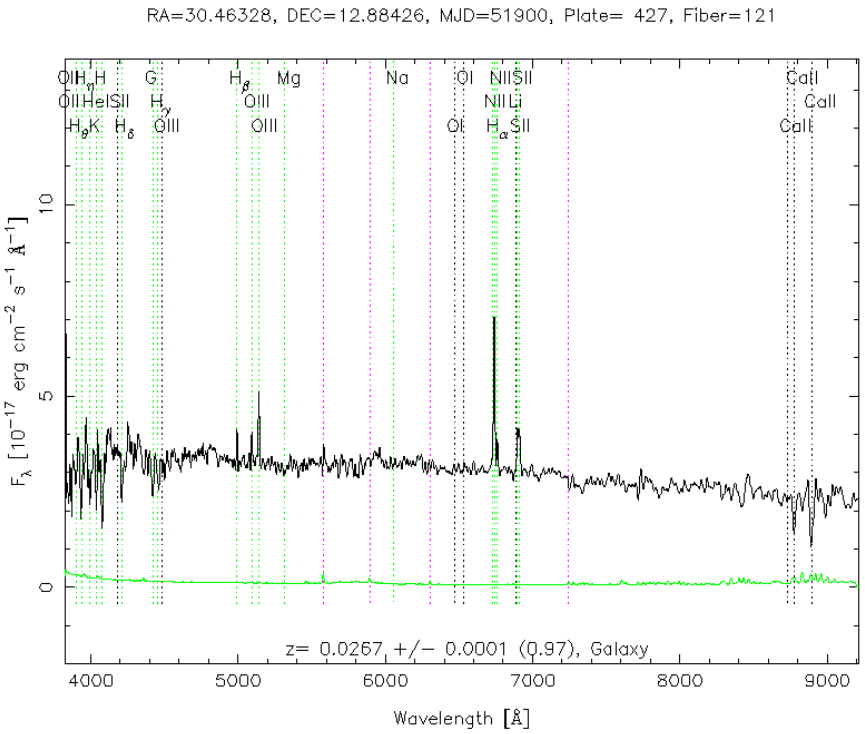
$$\text{N2} = \log \frac{[NII]\lambda 6583}{H_\alpha}$$

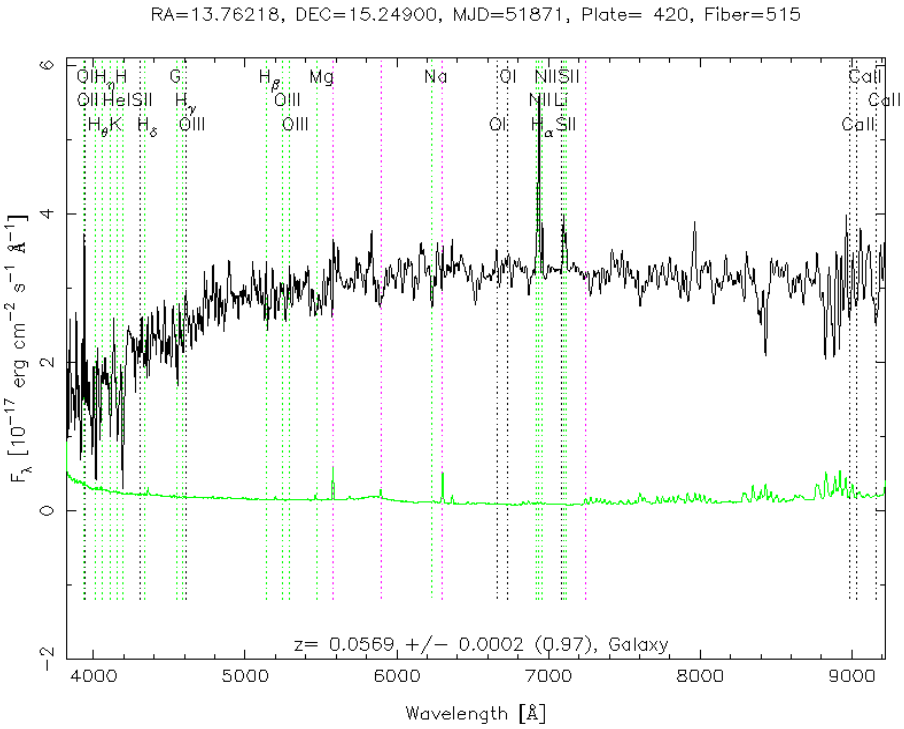
6.- No need for AGN removal

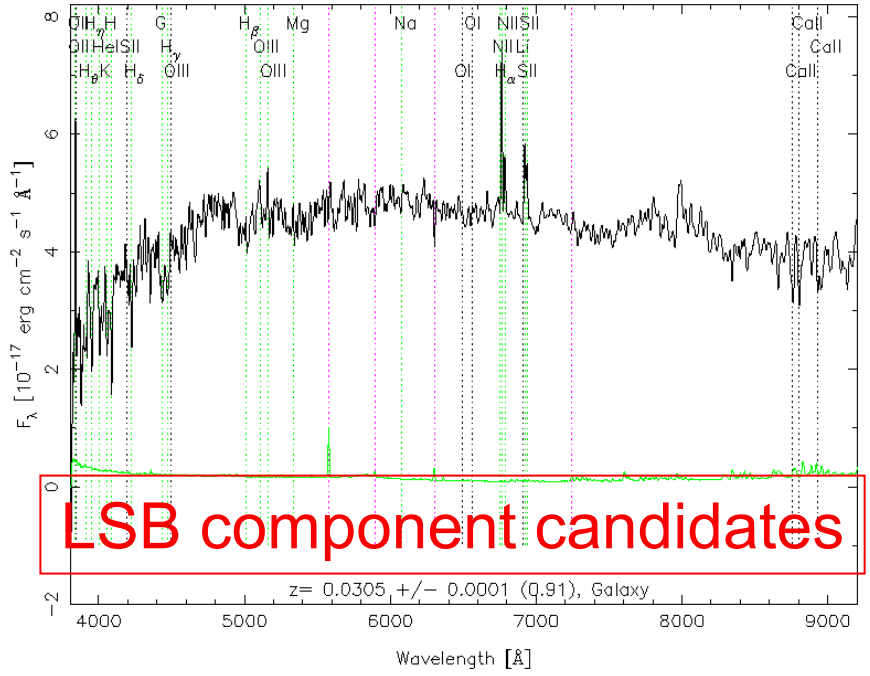


1747 BCD candidates

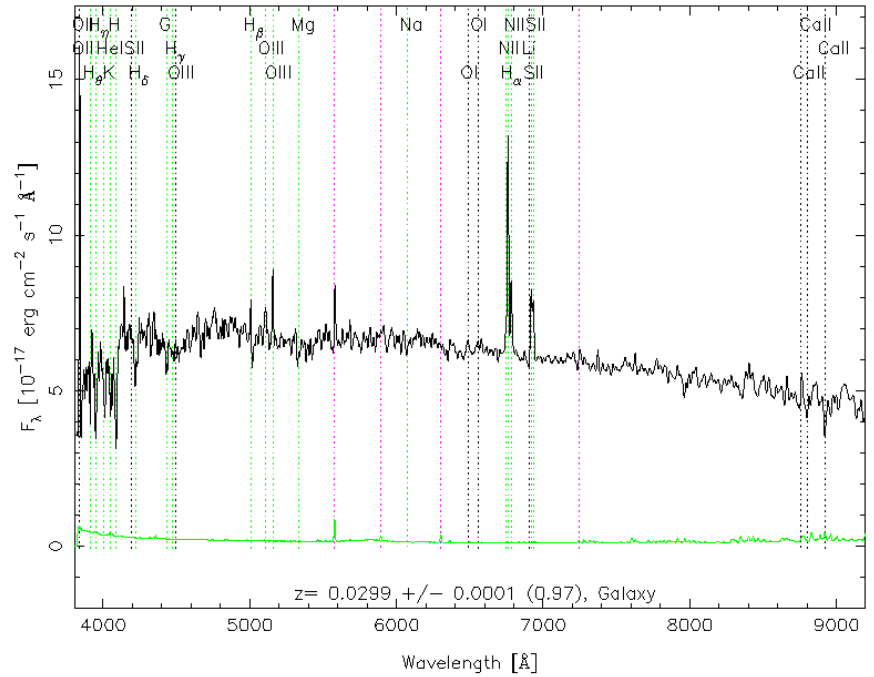

SDSS DR5
ra: 30.463 dec: 12.884
scale: 0.1981 arcsec/pix
image zoom: 4:1
10"
N
E
W
S
SDSS DR5
ra: 13.762 dec: 15.249
scale: 0.0990 arcsec/pix
image zoom: 16:1
5"
N
E
W
S
SDSS DR5
ra: 145.928 dec: 0.531
scale: 0.1981 arcsec/pix
image zoom: 4:1
10"
N
E
W
S
ra: 257.197 dec: 57.169
scale: 0.1981 arcsec/pix
image zoom: 4:1
10"
E
W
S
LSB component candidates



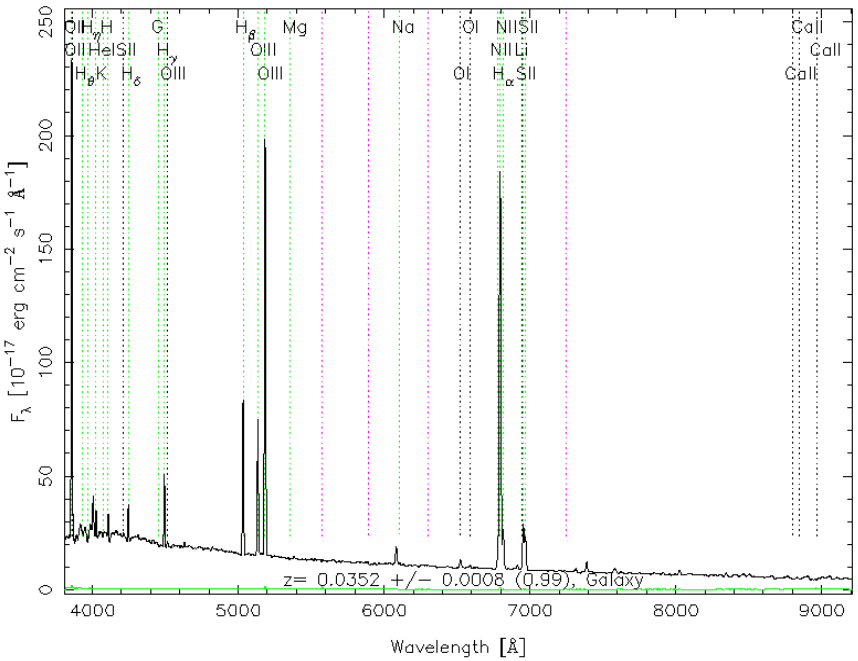




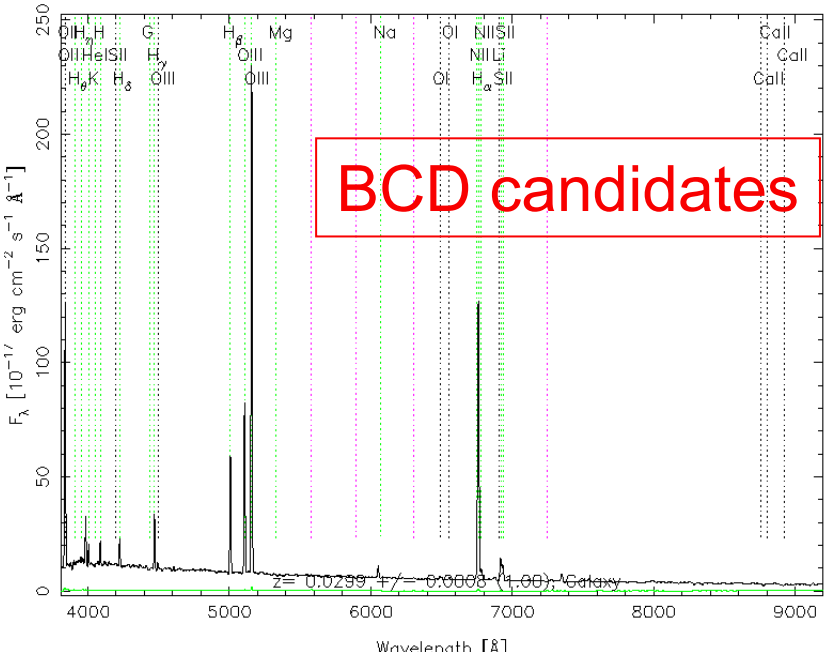
LSB component candidates

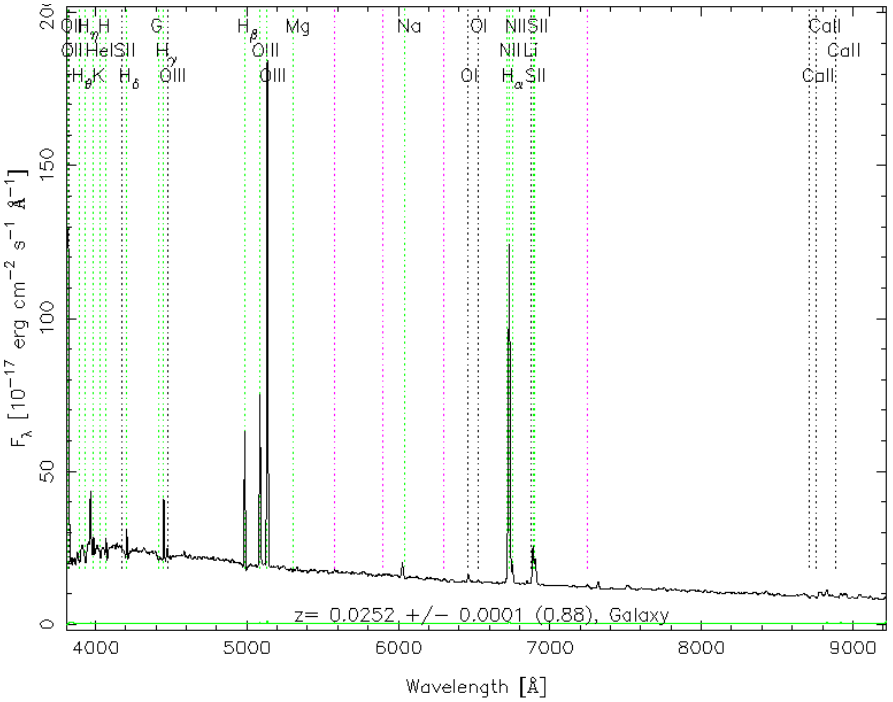


RA=183.01382, DEC=−0.60603, MJD=52023, Plate= 287, Fiber=236

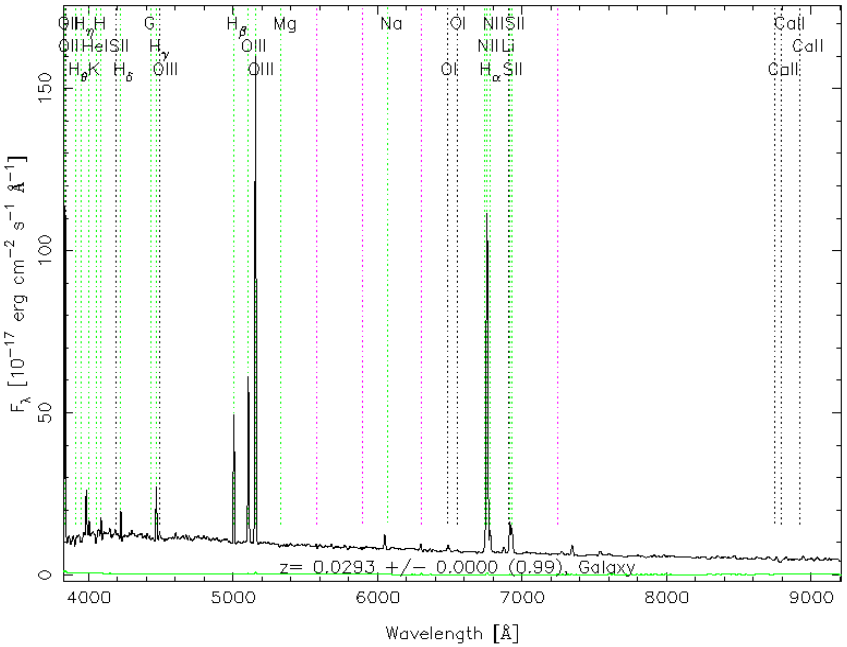


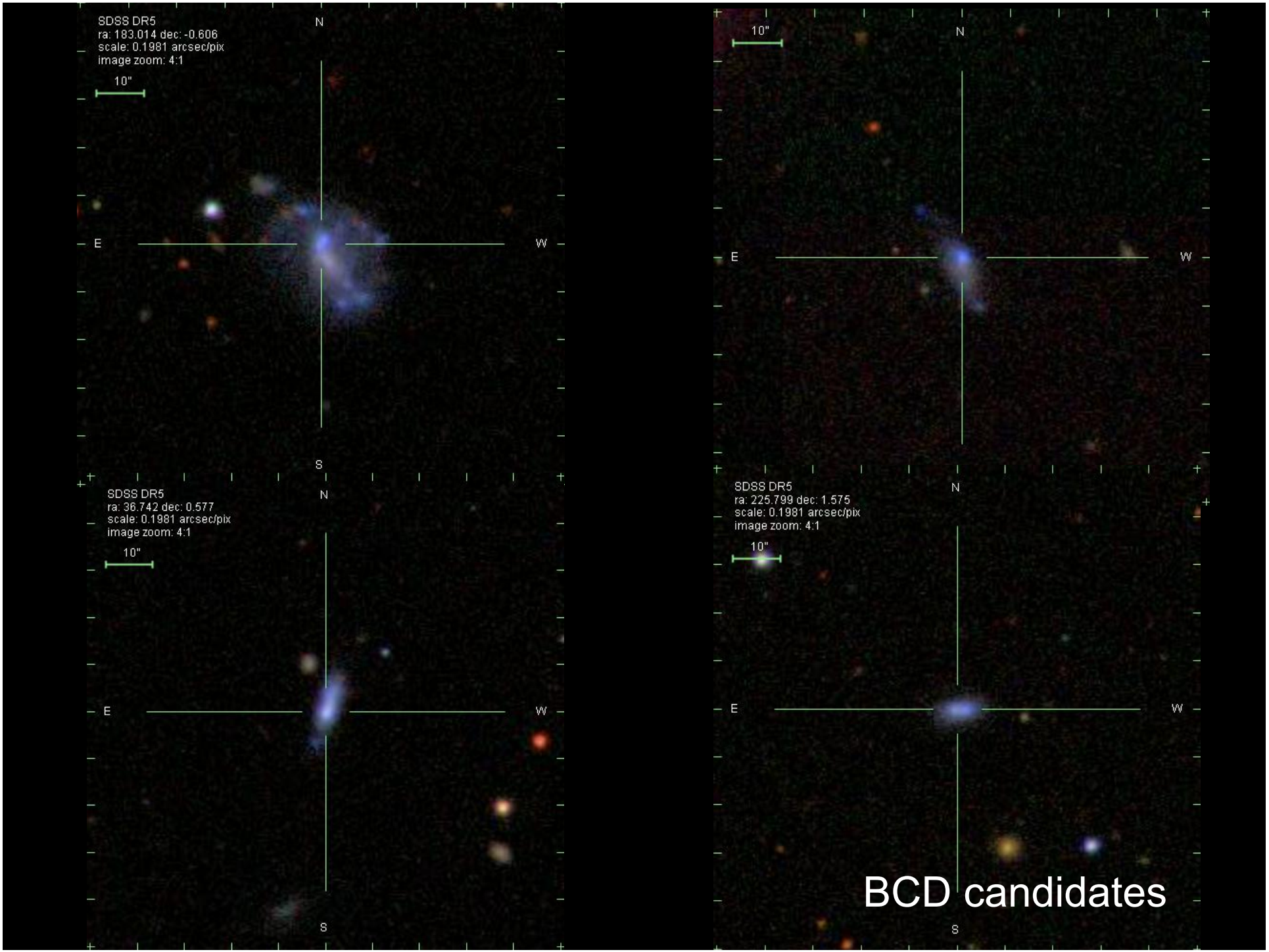
RA=349.37335, DEC=−0.85109, MJD=51816, Plate= 382, Fiber=134





RA=225.79930, DEC= 1.57512, MJD=52017, Plate= 539, Fiber=155




SDSS DR5
ra: 183.014 dec: -0.606
scale: 0.1981 arcsec/pix
image zoom: 4:1
10"
N
E
W
S
SDSS DR5
ra: 36.742 dec: 0.577
scale: 0.1981 arcsec/pix
image zoom: 4:1
10"
N
E
W
S
10"
N
E
W
S
SDSS DR5
ra: 225.799 dec: 1.575
scale: 0.1981 arcsec/pix
image zoom: 4:1
10"
N
E
W
S
BCD candidates

Results:

- 5387 candidates, i.e., quite a lot…
  but this is all.

- Sub-solar O/H abundance, but metal rich compared to the BCD candidates. Post BCD phase?

- Surface Brightness $\mu_g \sim 23$ mag, i.e., two orders of magnitude fainter than the BCD candidates.

- Redder than the BCDs, but still blue: $g - r \approx 0.5$

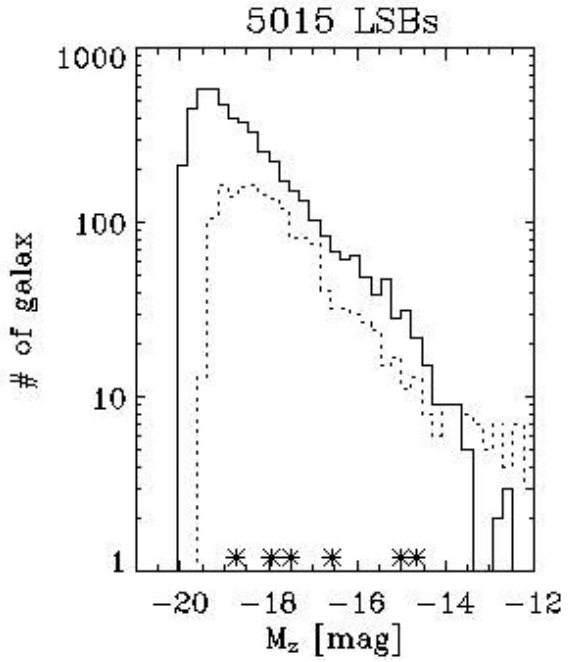
  $g - r \approx 0.25$ for a F3 star
  $g - r \approx 0.45$ for a G0 star
  $g - r \approx 1.16$ for a K2 star

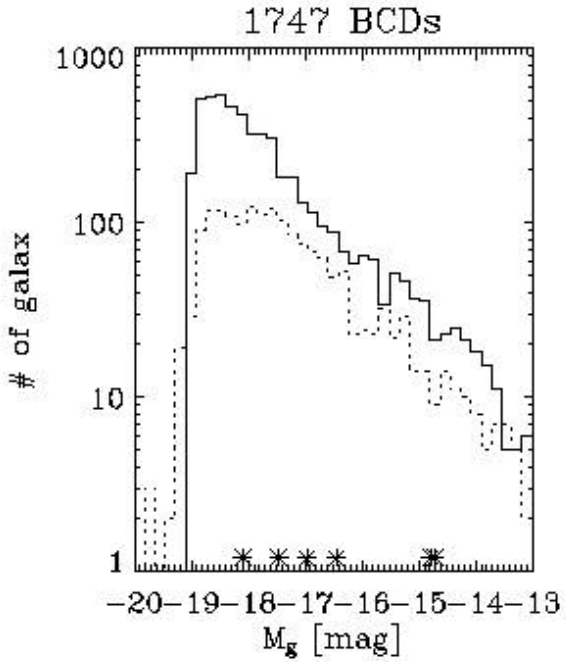
- $W_{H_\alpha} \approx 10$ Å (not a selection criterion)

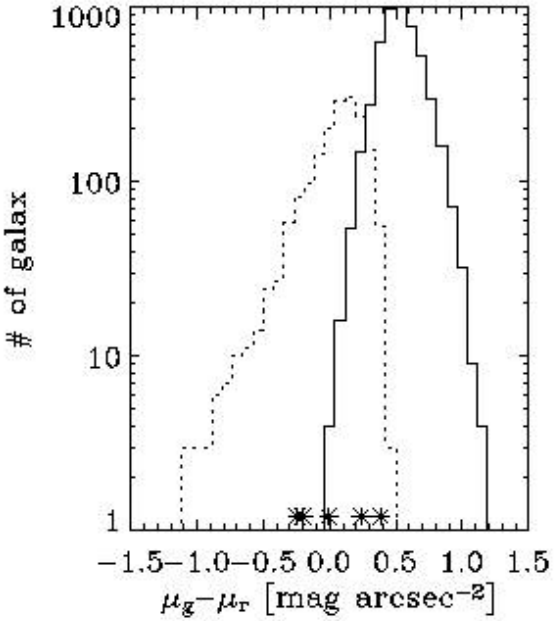
- Too bright to be true candidates?

  The brightest host galaxies candidates are brighter then the brightest BCD candidates, which is inconsistent.

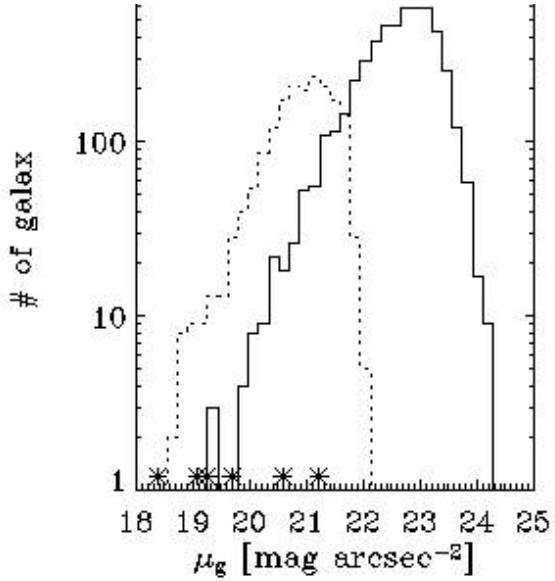
  The set of brightest host galaxies candidates is suspicious

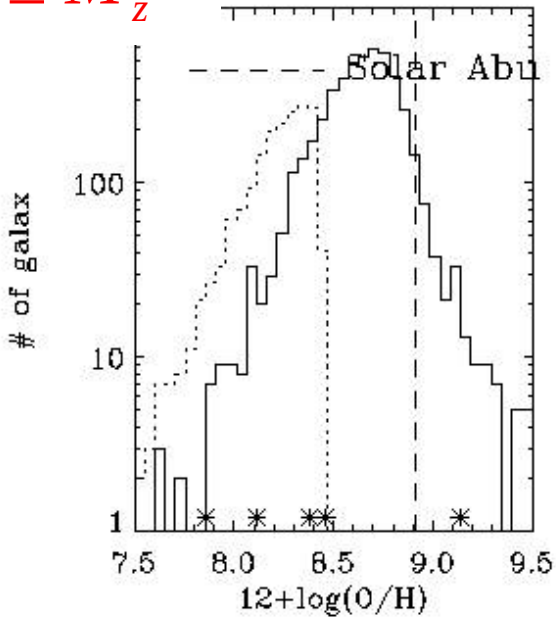


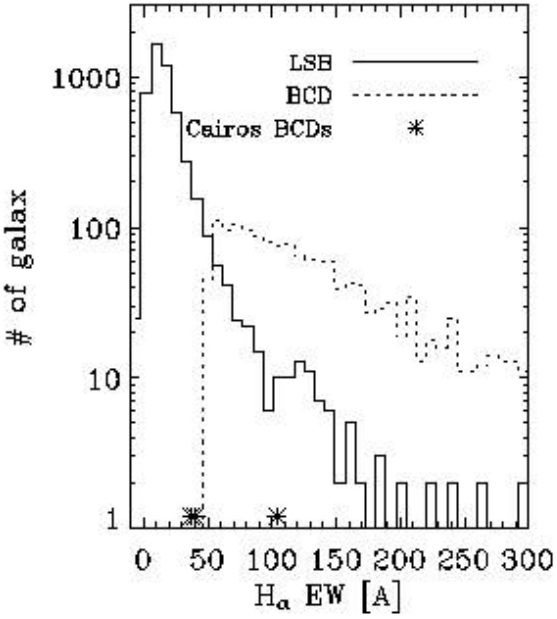




$-19 \le M_g$ and $-20 \le M_z$







❑ Luminosity Functions

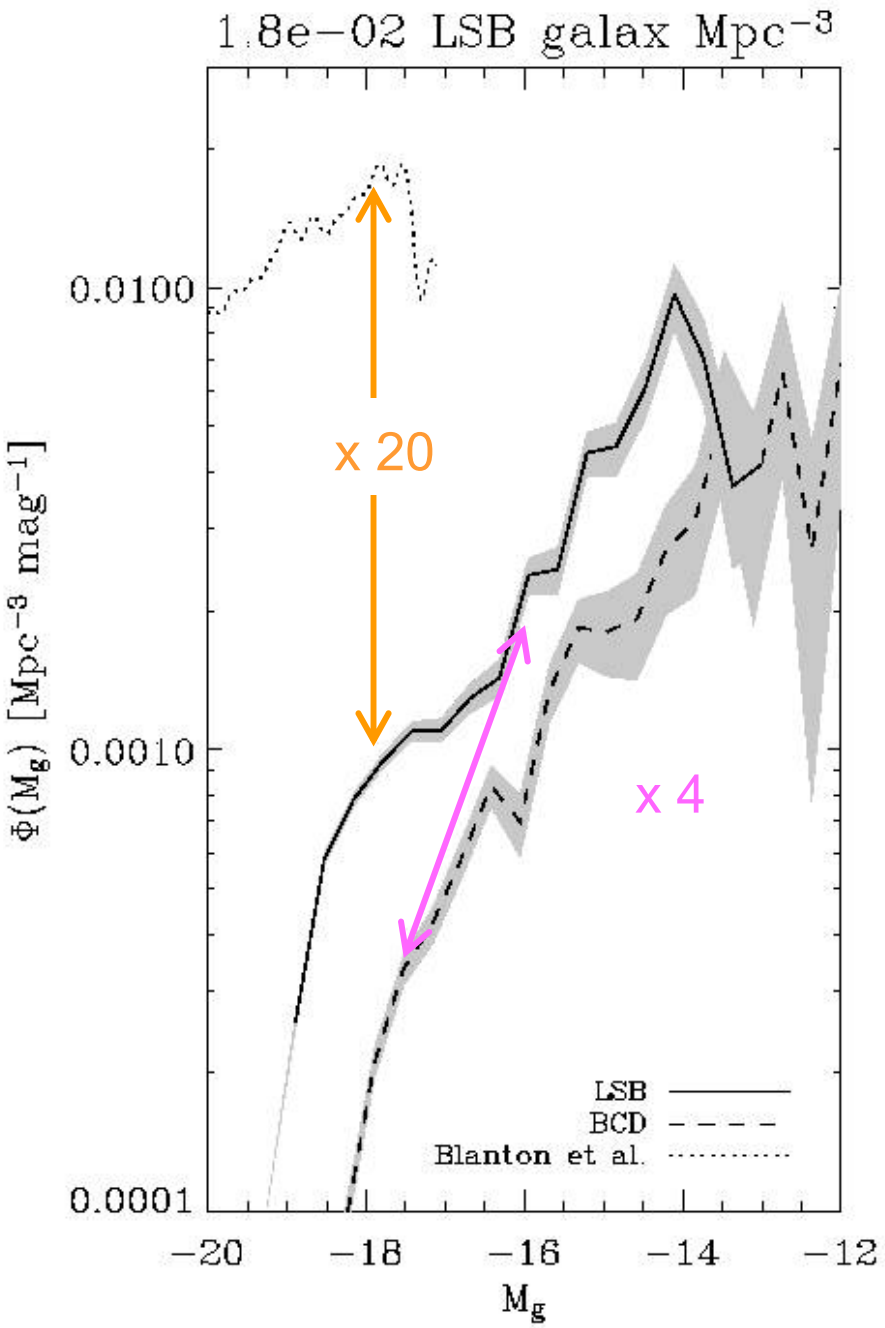
Since the BCD phase is much shorter the the galaxy lifetime, one should expect much more host galaxy candidates per volume than BCD candidates.

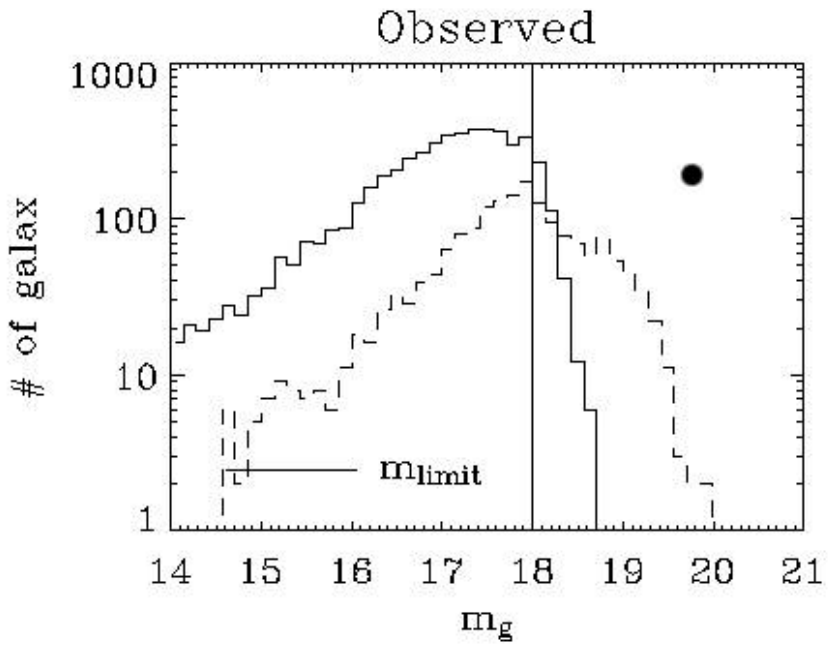
$$\Phi(M) \equiv \quad \#\ \text{of galax per unit mag and volume}$$

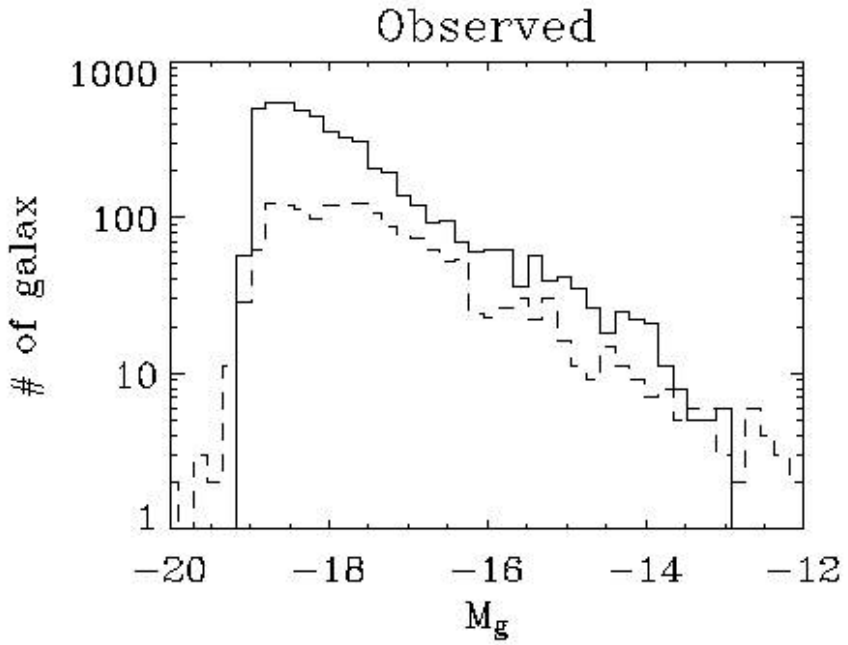
Two different estimates; (1) the so-called $1/V_{max}$ estimate, and (2) a maximum likelihood estimate (Efstathiou et al. 88) supplemented with a method to compute the total galaxy density (Davis & Huchra 82). Bootstrap errors included.

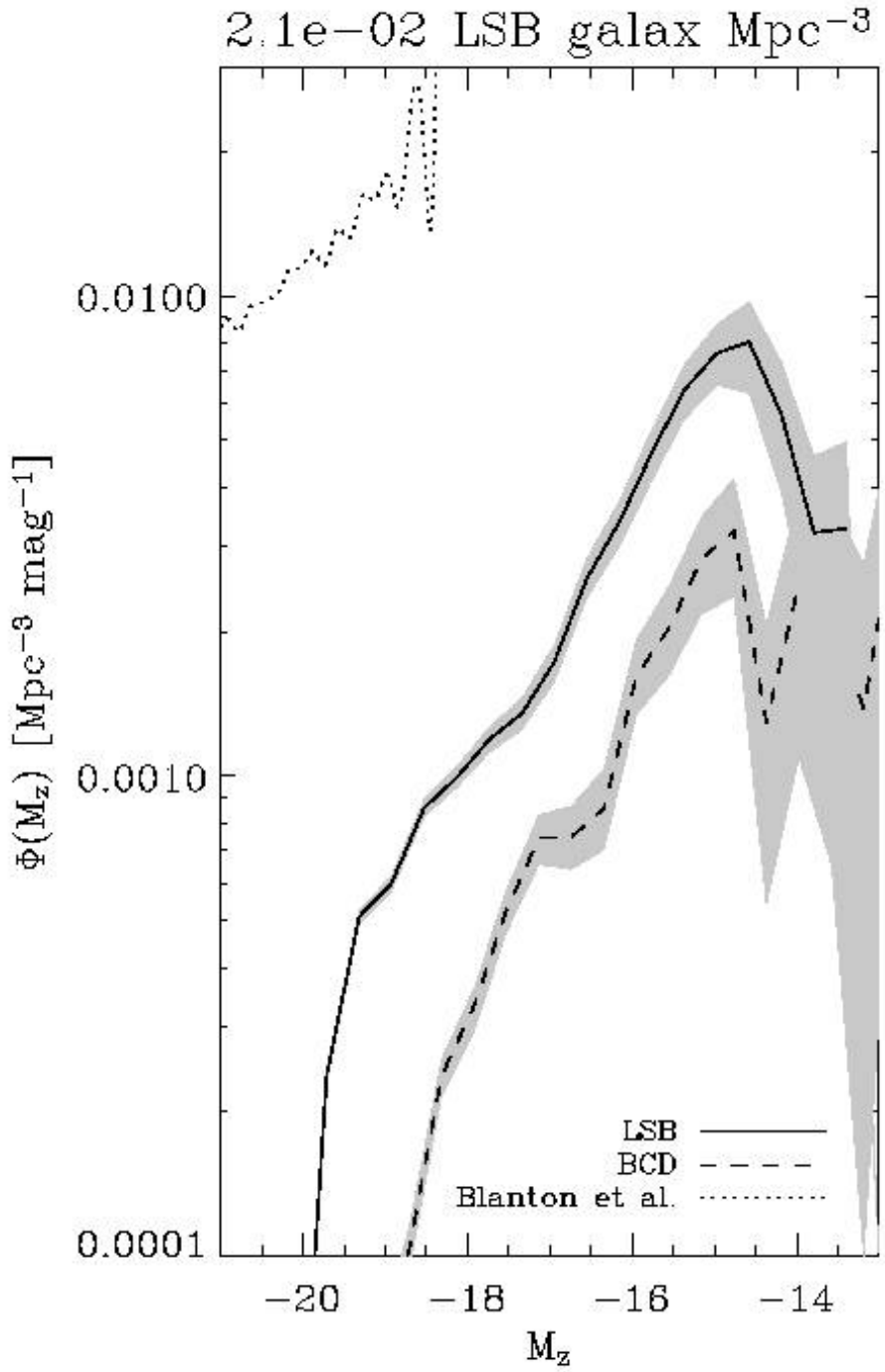
The two estimates give similar results (?) →

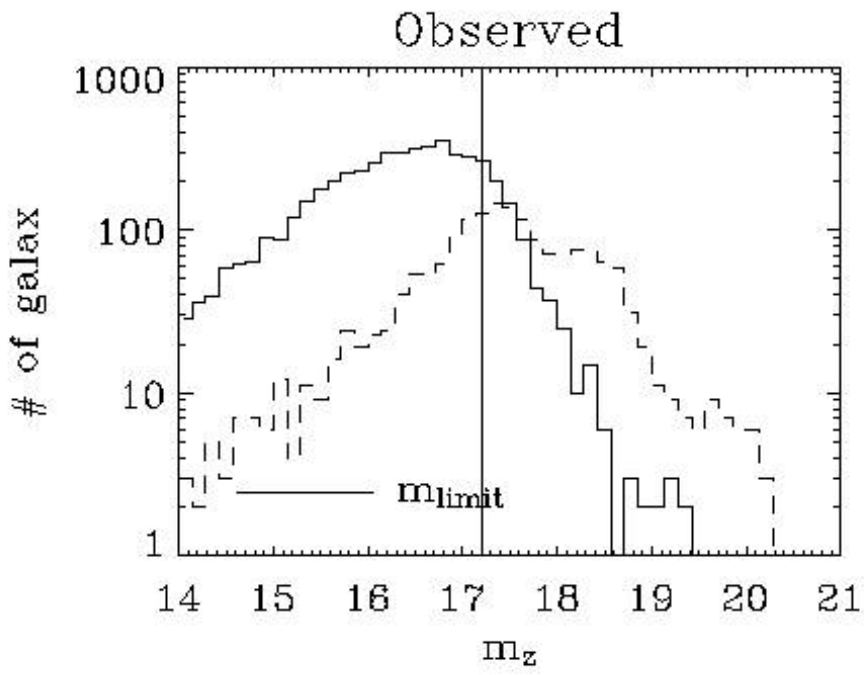


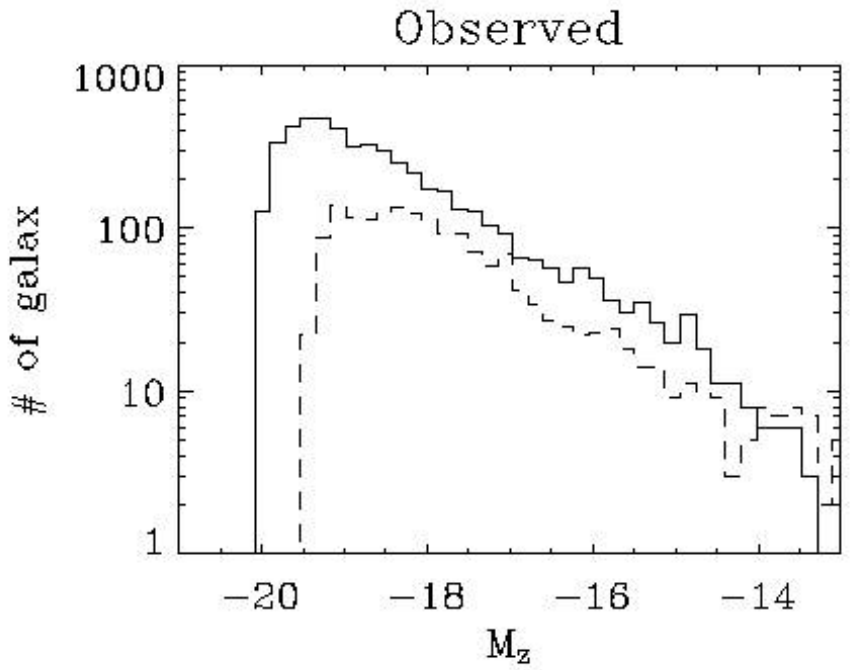

1.8e−02 LSB galax Mpc^{-3}
0.0100
0.0010
0.0001
$\Phi(M_g)$ [Mpc^{-3} mag^{-1}]
x 20
x 4
LSB
BCD
Blanton et al.
−20
−18
−16
−14
−12
M_g


Observed
1000
100
10
1
# of galax
m_{limit}
14
15
16
17
18
19
20
21
m_g


Observed
1000
100
10
1
# of galax
−20
−18
−16
−14
−12
M_g


2.1e−02 LSB galax Mpc^{-3}
0.0100
0.0010
0.0001
$\Phi(M_z)$ [Mpc^{-3} mag^{-1}]
LSB
BCD
Blanton et al.
−20
−18
−16
−14
M_z


Observed
1000
100
10
1
# of galax
m_{limit}
14
15
16
17
18
19
20
21
m_z


Observed
1000
100
10
1
# of galax
−20
−18
−16
−14
M_z

DBD...(To be done)

✓ Using starburst models (e.g., Leitherer et al 99), to determine the time evolution of the LF of the host galaxy candidates consistent with the LF of the BCD candidates. (Instant or extended star formation; lifetime of the starburst).

✓ Estimate SFRs from H_α equivalent widths.

✓ In depth analysis of a small set of randomly selected candidates to assess the reliability of the sample of host galaxy candidates and BCDs candidates. (Starting from the SDSS raw images and spectra.)

✓ LF of isolated SDSS galaxies to be used as a control sample for the host galaxy candidates (. To replace Blanton et al. LF)

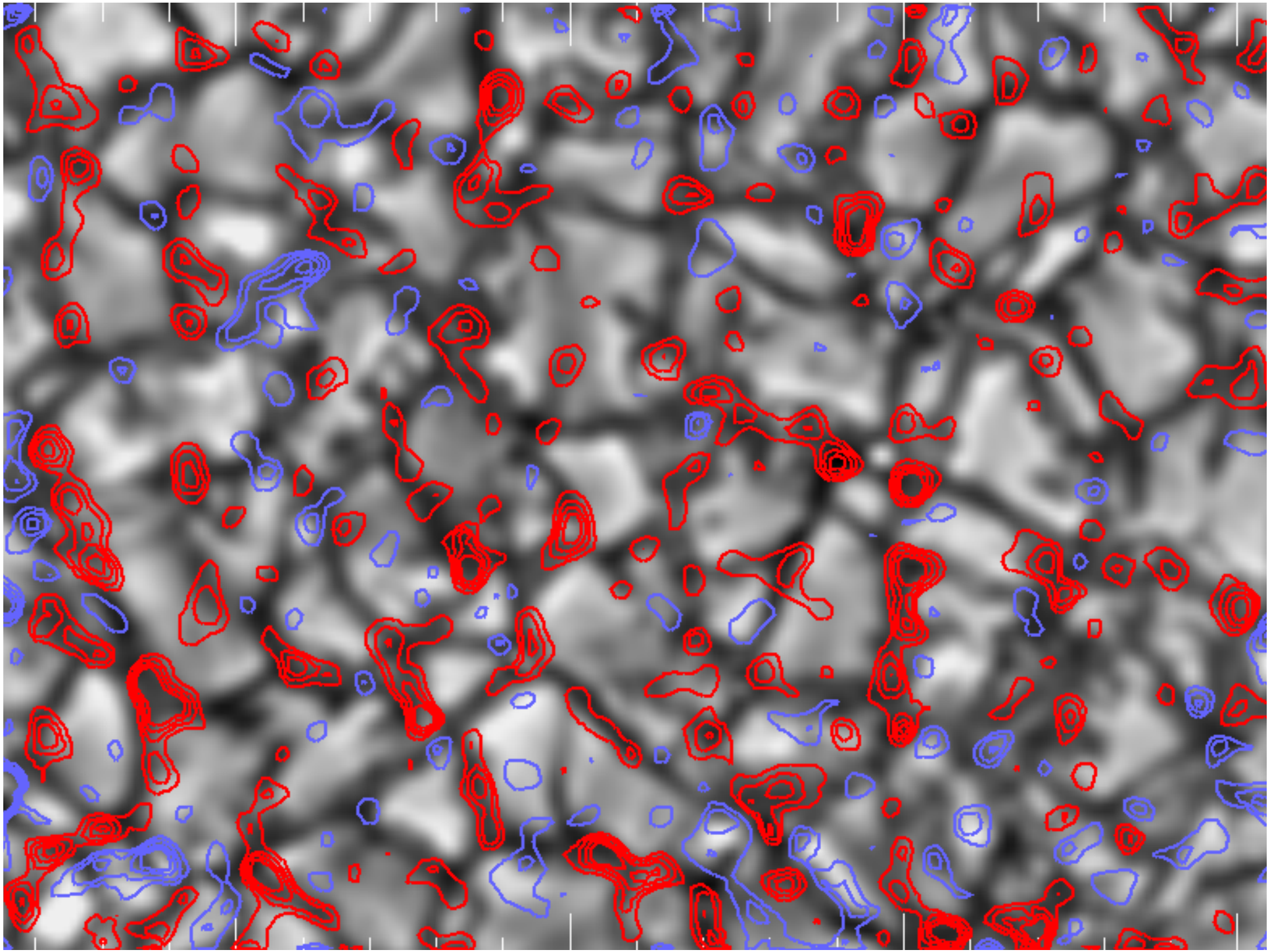
… additional suggestions are welcome

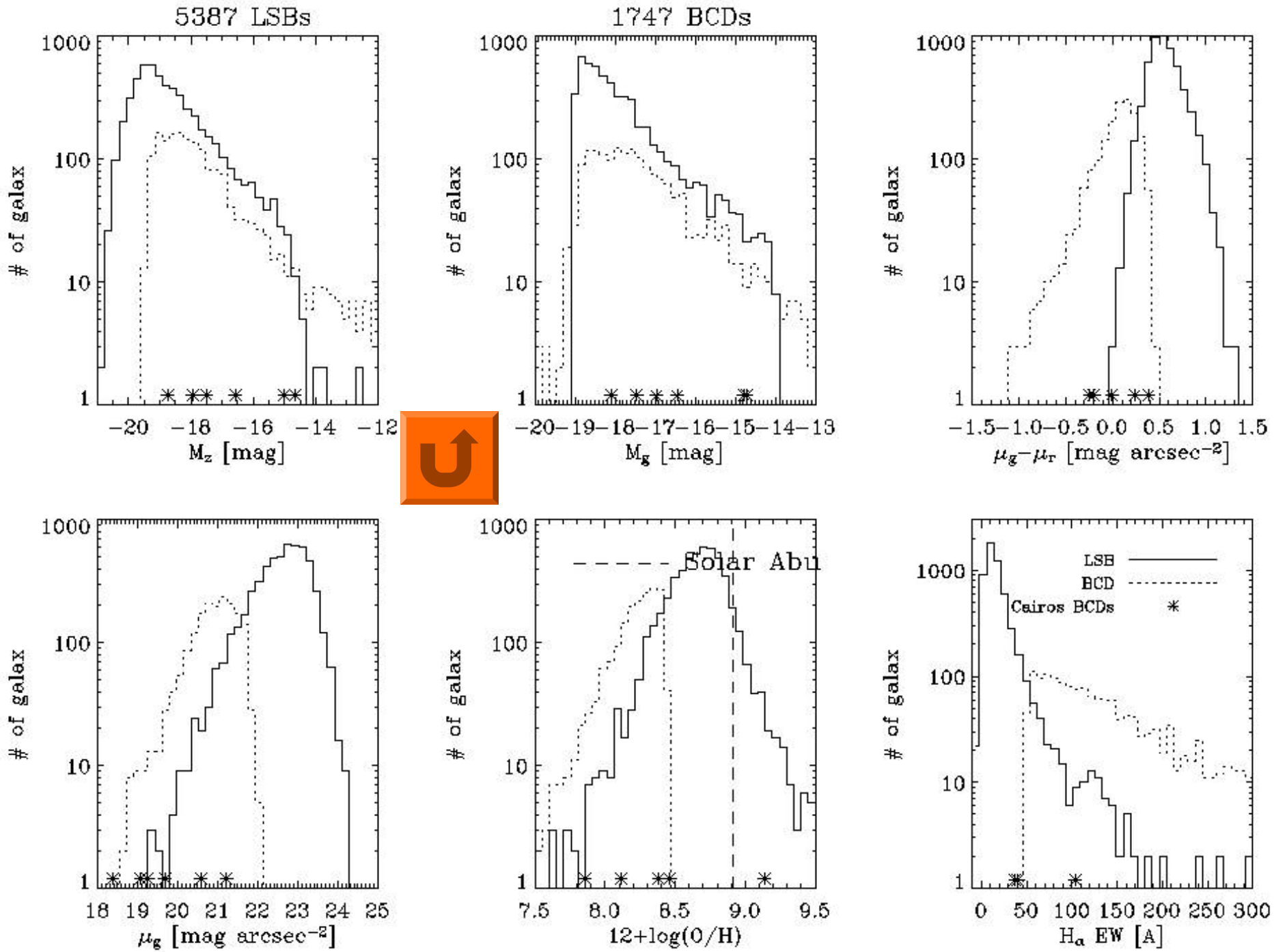
Summary - Conclusions

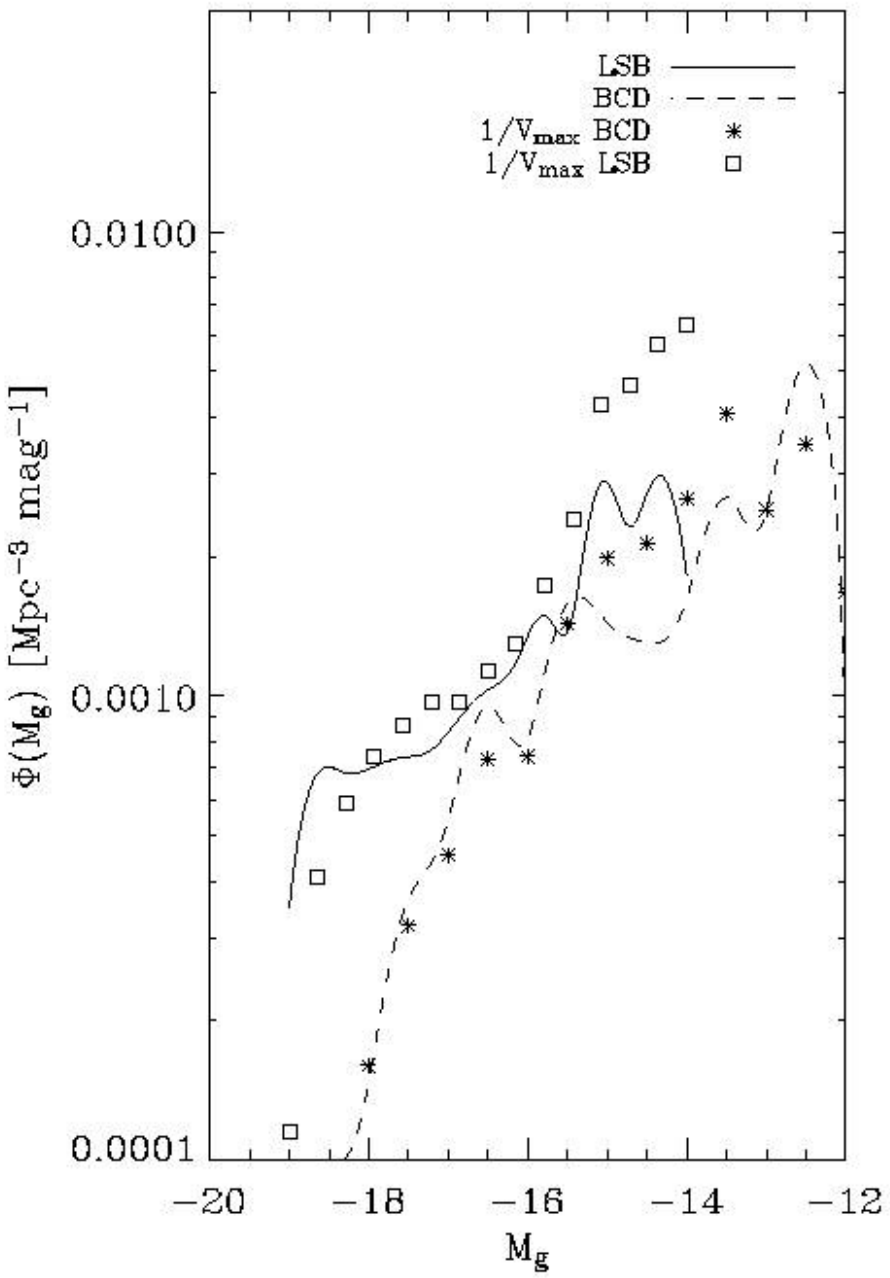
- Some 5000 BCD host galaxy candidates in SDSS/RD5. (~1700 BCD candidates.)… and there are no more candidates!
- They represent one out of 10 regular galaxies and, 4 times the number of BCD candidates.
- Sub-solar O/H abundance (~0.6 solar value). Post BCD phase?
- $W_{H_\alpha} \approx 10$ Å low SFR, but different from zero
- Redder than the BCDs, but blue: $g - r \approx 0.5$

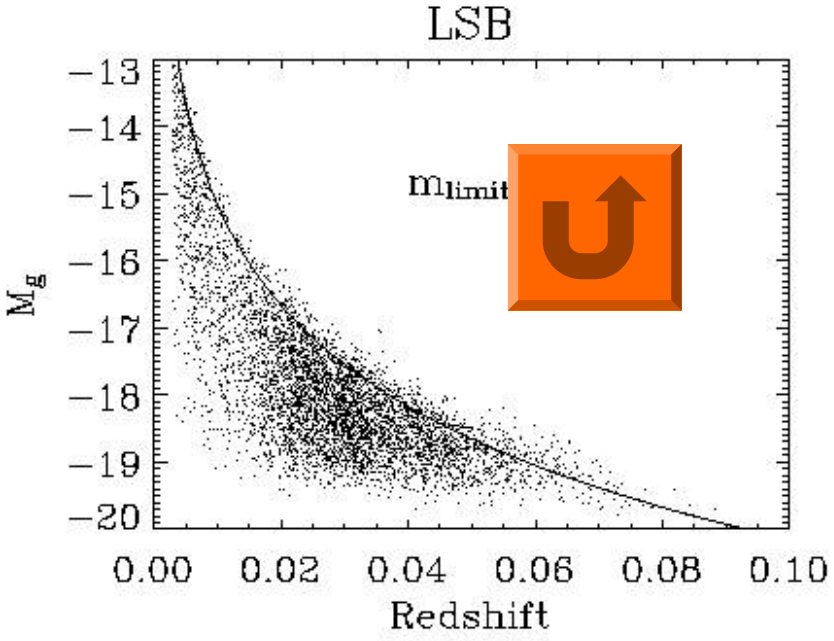
- Are the BCD host galaxy candidates another phase of a much broader class of galaxies?

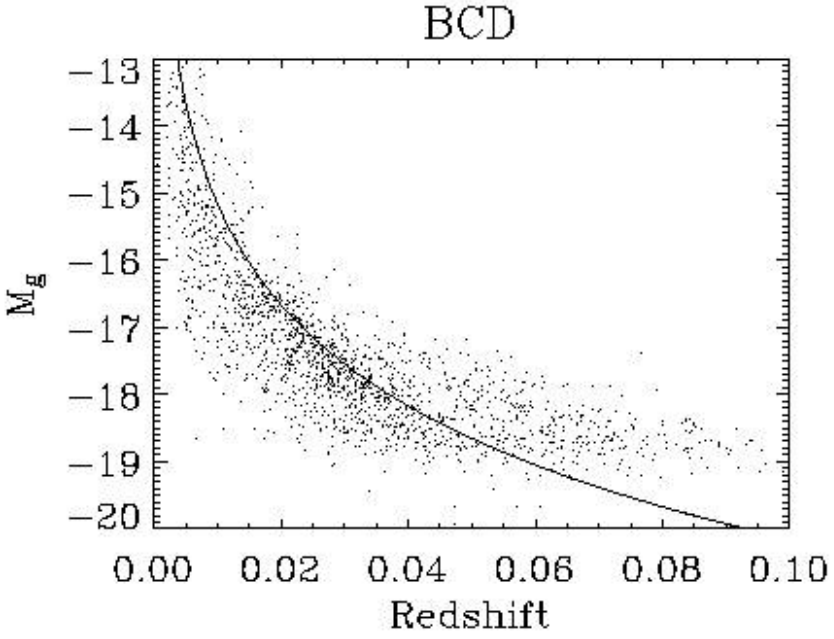
- Can we fairly use the properties of the LSB candidates to host of BCDs to characterize the properties of host galaxy? In principle, NO … but there nothing better available and therefore it is a valid working hypothesis

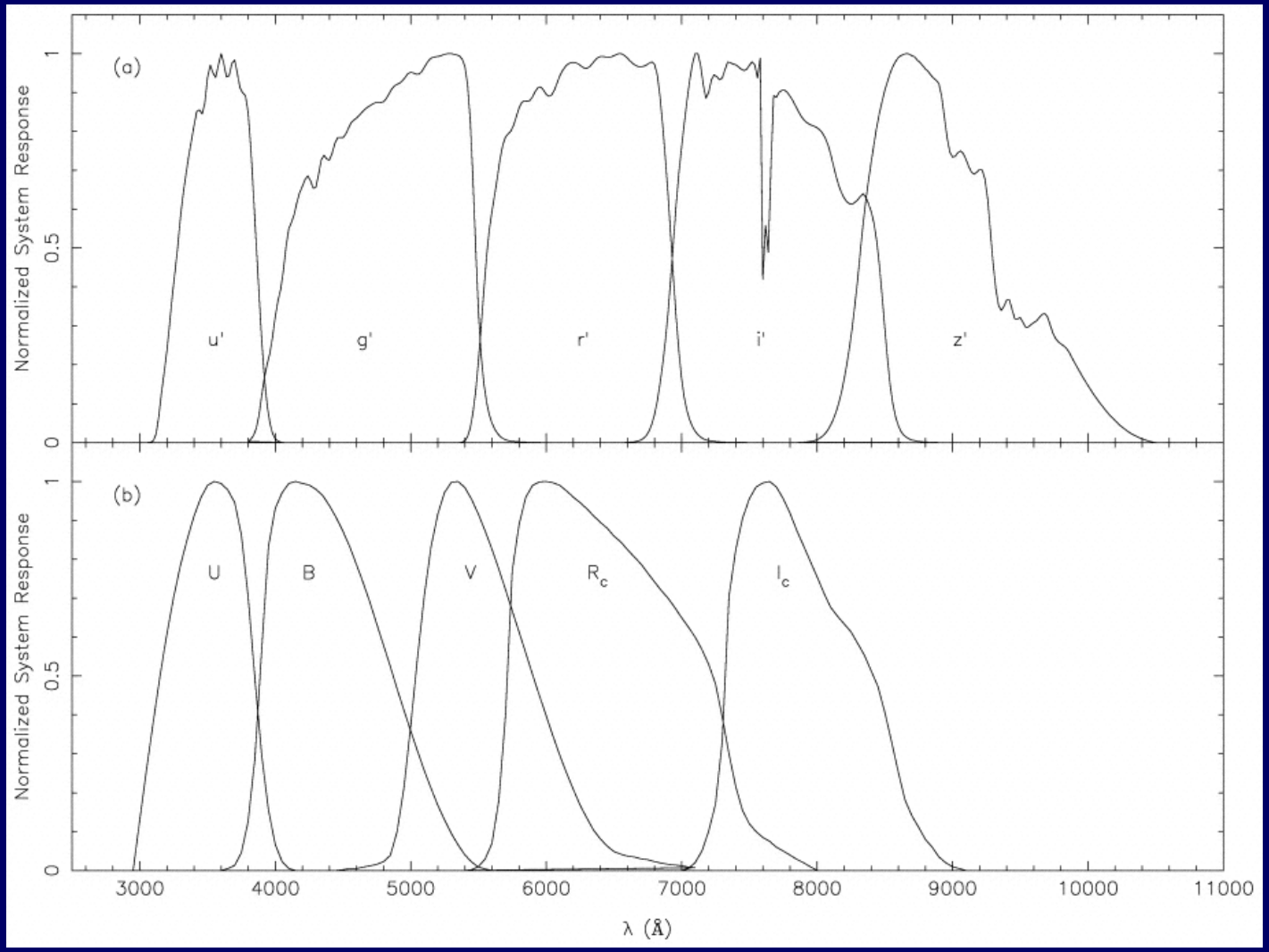



5387 LSBs
1747 BCDs
# of galax
1000
100
10
1
−20 −18 −16 −14 −12
M_z [mag]
−20−19−18−17−16−15−14−13
M_g [mag]
−1.5−1.0−0.5 0.0 0.5 1.0 1.5
$\mu_g-\mu_r$ [mag arcsec^{-2}]
18 19 20 21 22 23 24 25
μ_g [mag arcsec^{-2}]
Solar Abu
7.5 8.0 8.5 9.0 9.5
12+log(O/H)
LSB
BCD
Cairos BCDs
0 50 100 150 200 250 300
H_α EW [A]


LSB
BCD
1/V_max BCD
1/V_max LSB
0.0100
0.0010
0.0001
Φ(M_g) [Mpc^-3 mag^-1]
−20
−18
−16
−14
−12
M_g

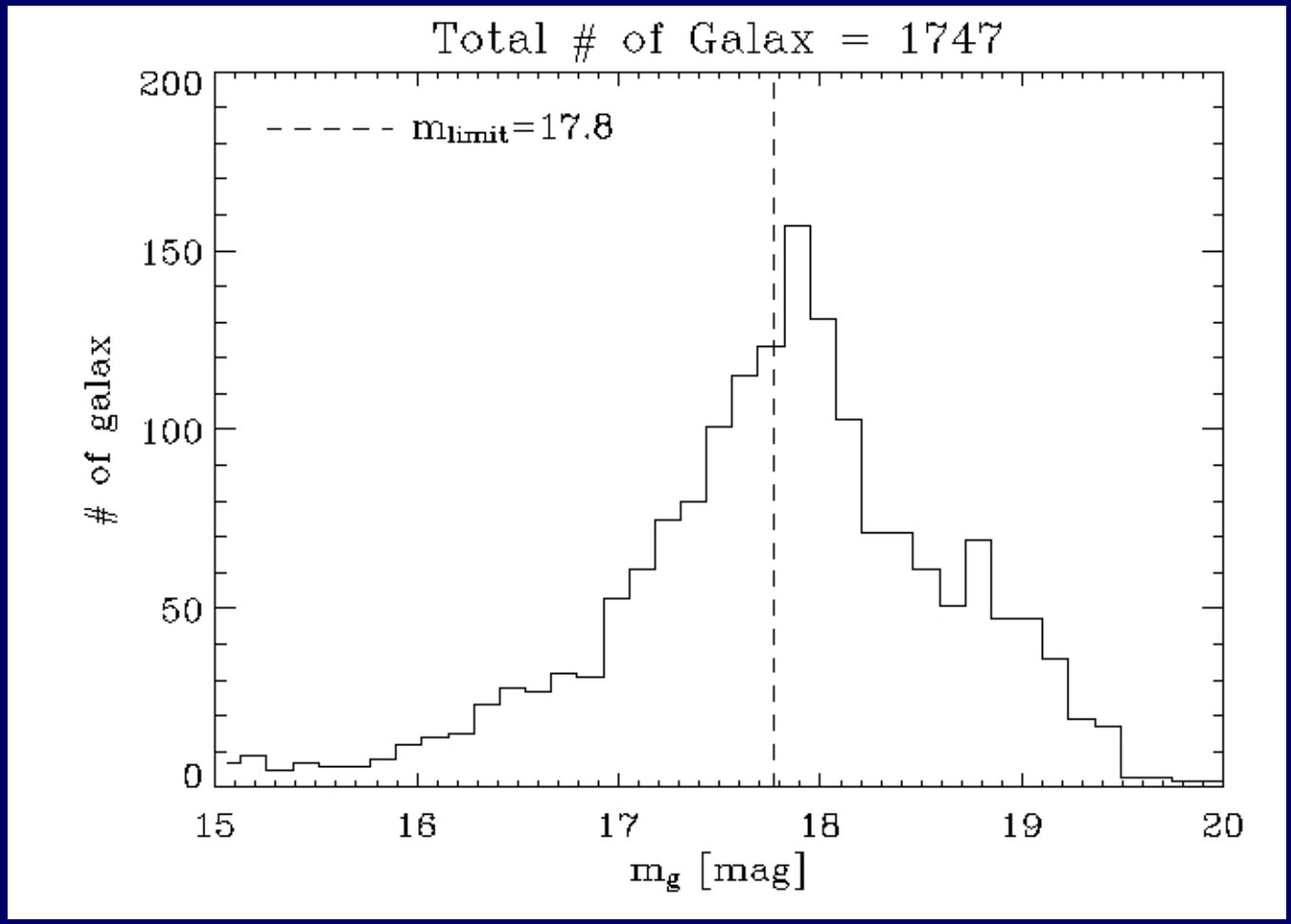

LSB
m_limit
−13
−14
−15
−16
−17
−18
−19
−20
M_g
0.00
0.02
0.04
0.06
0.08
0.10
Redshift

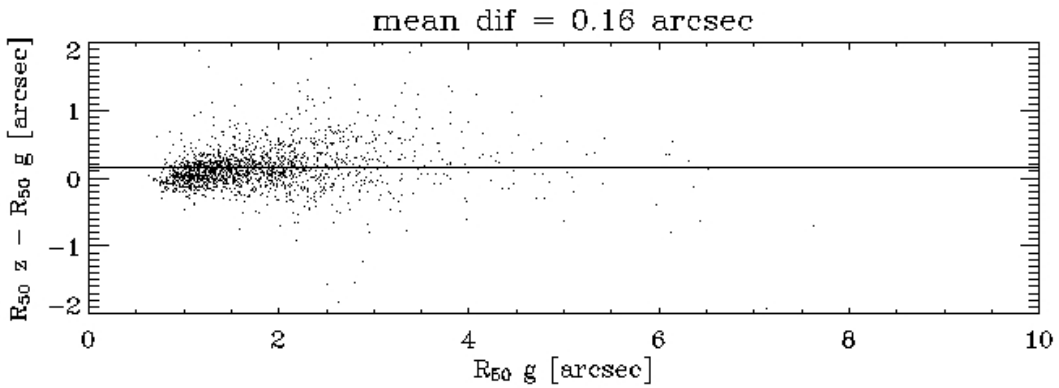

BCD
−13
−14
−15
−16
−17
−18
−19
−20
M_g
0.00
0.02
0.04
0.06
0.08
0.10
Redshift

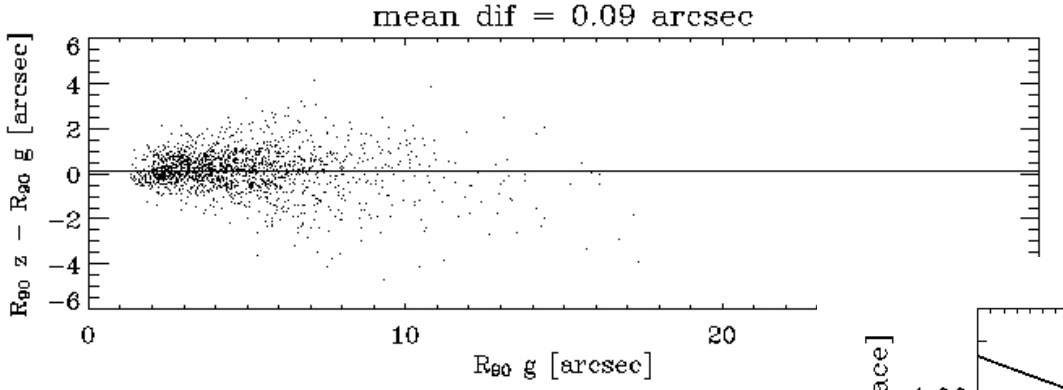


SDSS vs UBVRI (smith et al. 2002)

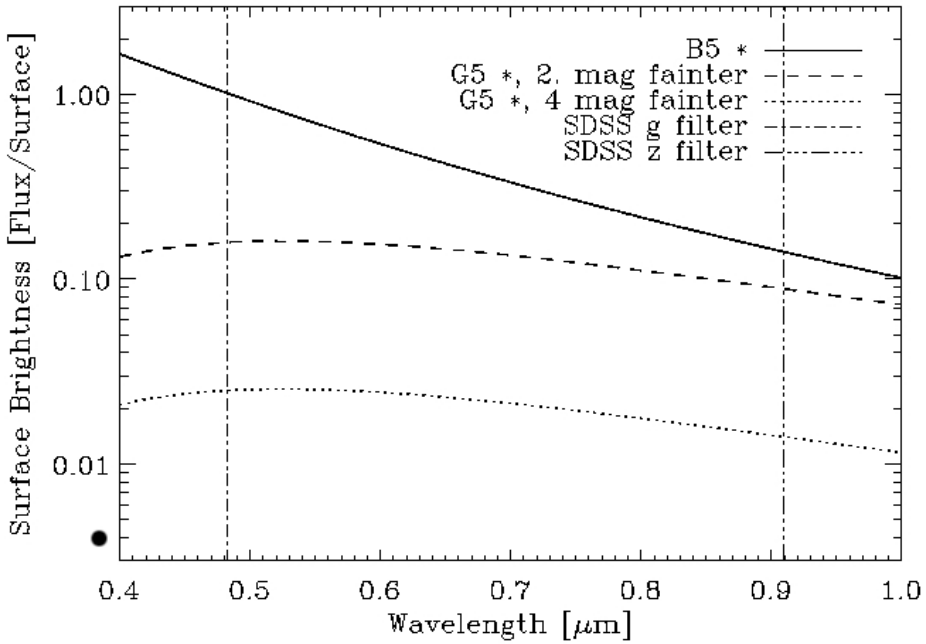
BCD candidates







← BCD candiates



March 2007, Graná

March 2007, Graná