Deep multiband surface photometry on 45 star forming BCGs

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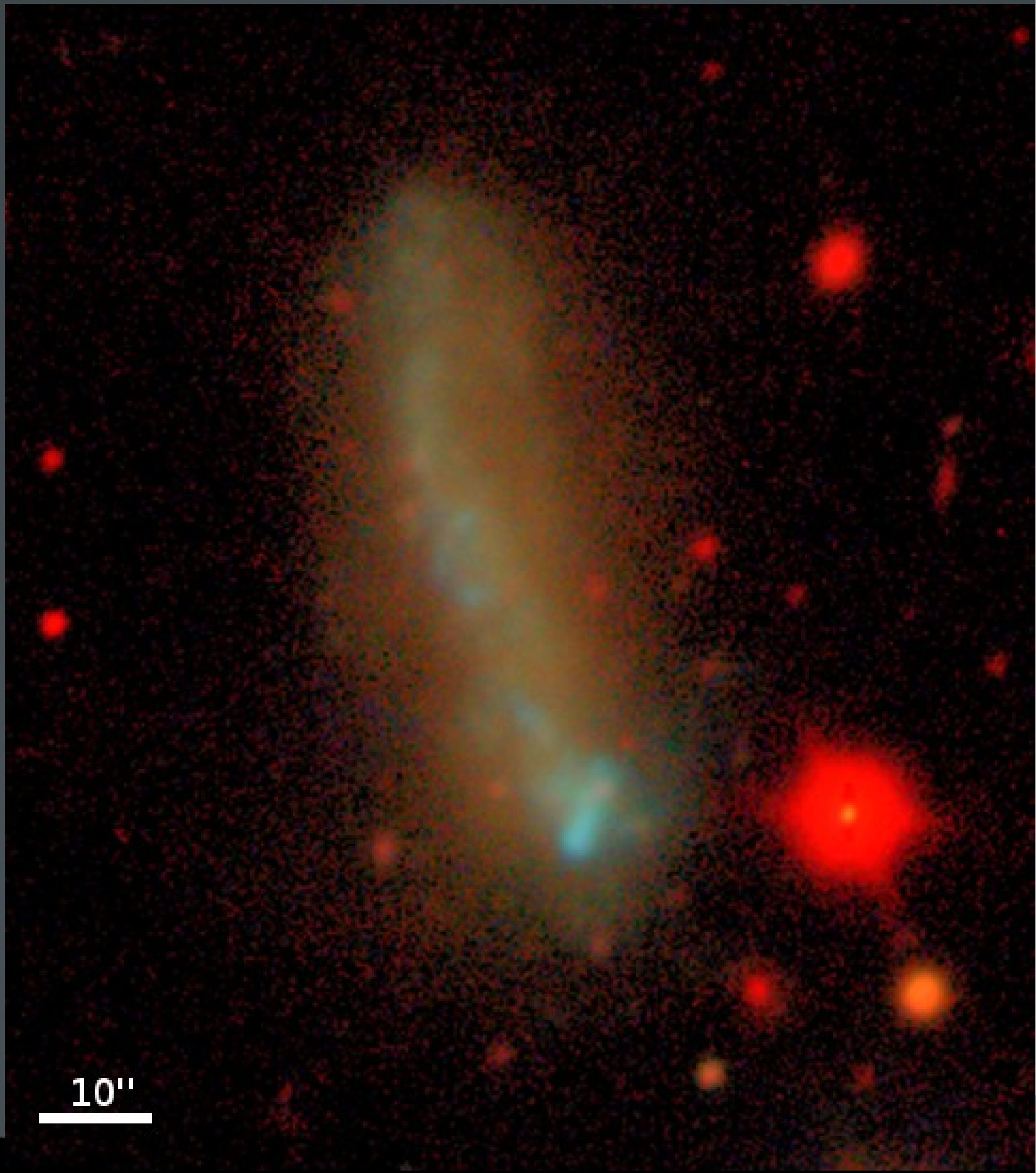
Outline

- Blue compact galaxies? Why?
- Observations
- Low vs. High luminosity BCGs
  - Structural parameters
  - Asymmetry & concentration
- Conclusions

UM133



Blue Compact Galaxies (BCGs)

- Metal-poor 10% $Z_{\odot}$ to close to $Z_{\odot}$
- Gas-rich, $M_{HI} \sim 10^6$-$10^9 M_{\odot}$
- (short) Bursts of star formation in an underlying old “host” galaxy
- SFR (Hα): 0.1-24 $M_{\odot}$/yr
- M/L: 0.1-0.8
- Emission line (HII) galaxies
- In some ways reminiscent of truly young galaxies at high z
- Nearby ⇒ surface photometry

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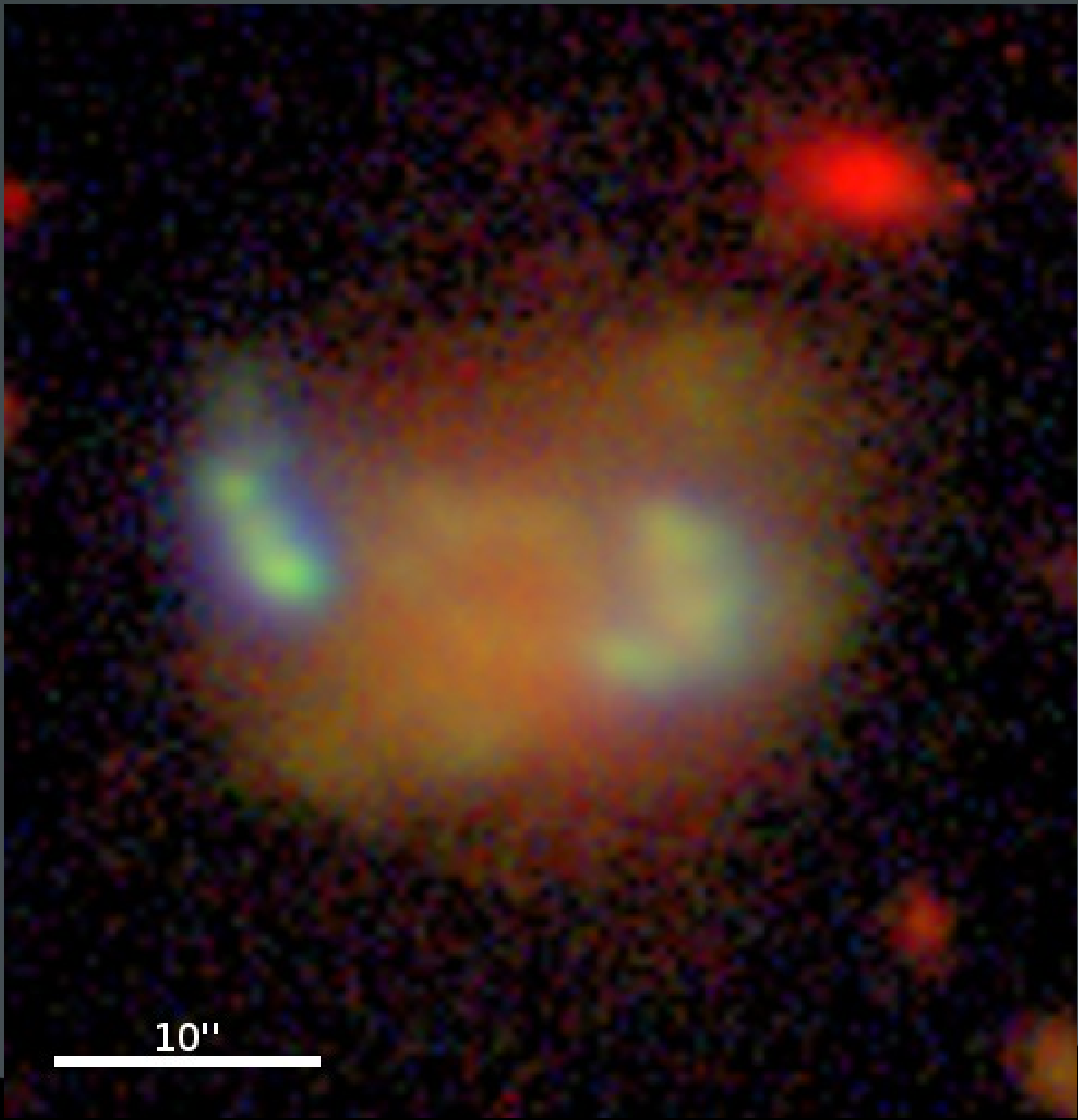


Why study BCGs?

SF dwarfs most common type of galaxy in local Universe – difficult to study in large numbers

Starbursting dwarfs more exotic but easier to detect

At high z they contributed to reionization of Universe

Can't study dwarfs at high-z, must infer their properties from local analogs, i.e. either dwarfs, starbursting galaxies, or both (starbursting dwarfs ≈ BCGs)

Problem:

-There are no exact analogs

-None of these are homogeneous groups: significant differences in morphology, total luminosity, colors, gas and dust content, kinematics, chemical abundances, star formation rates, stellar populations, dark matter content.

Observations

17 446 raw images of 46 BCGs

6 years of observations (2001-2007)

NOT, NTT, VLT

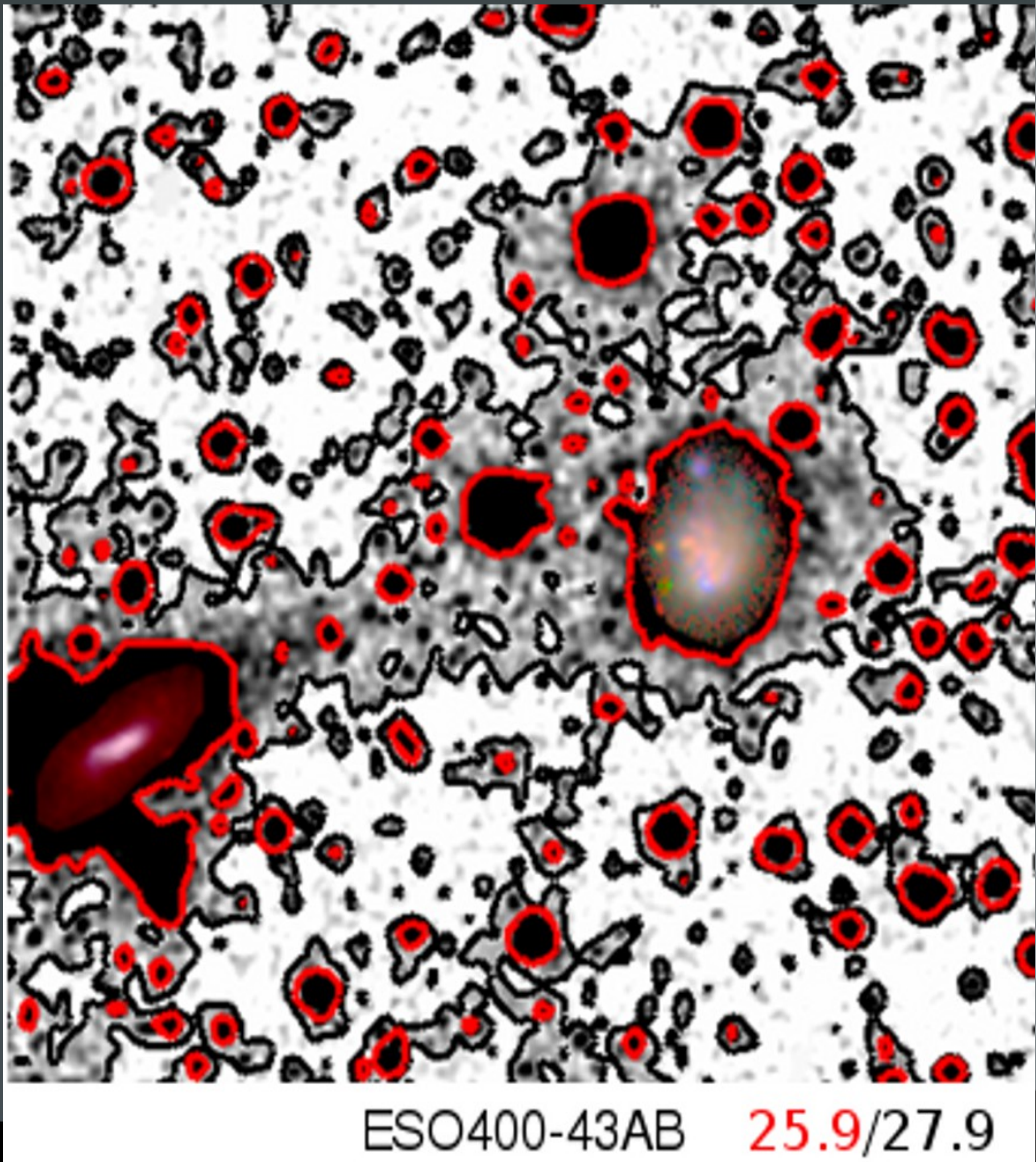
Optical & NIR broadband

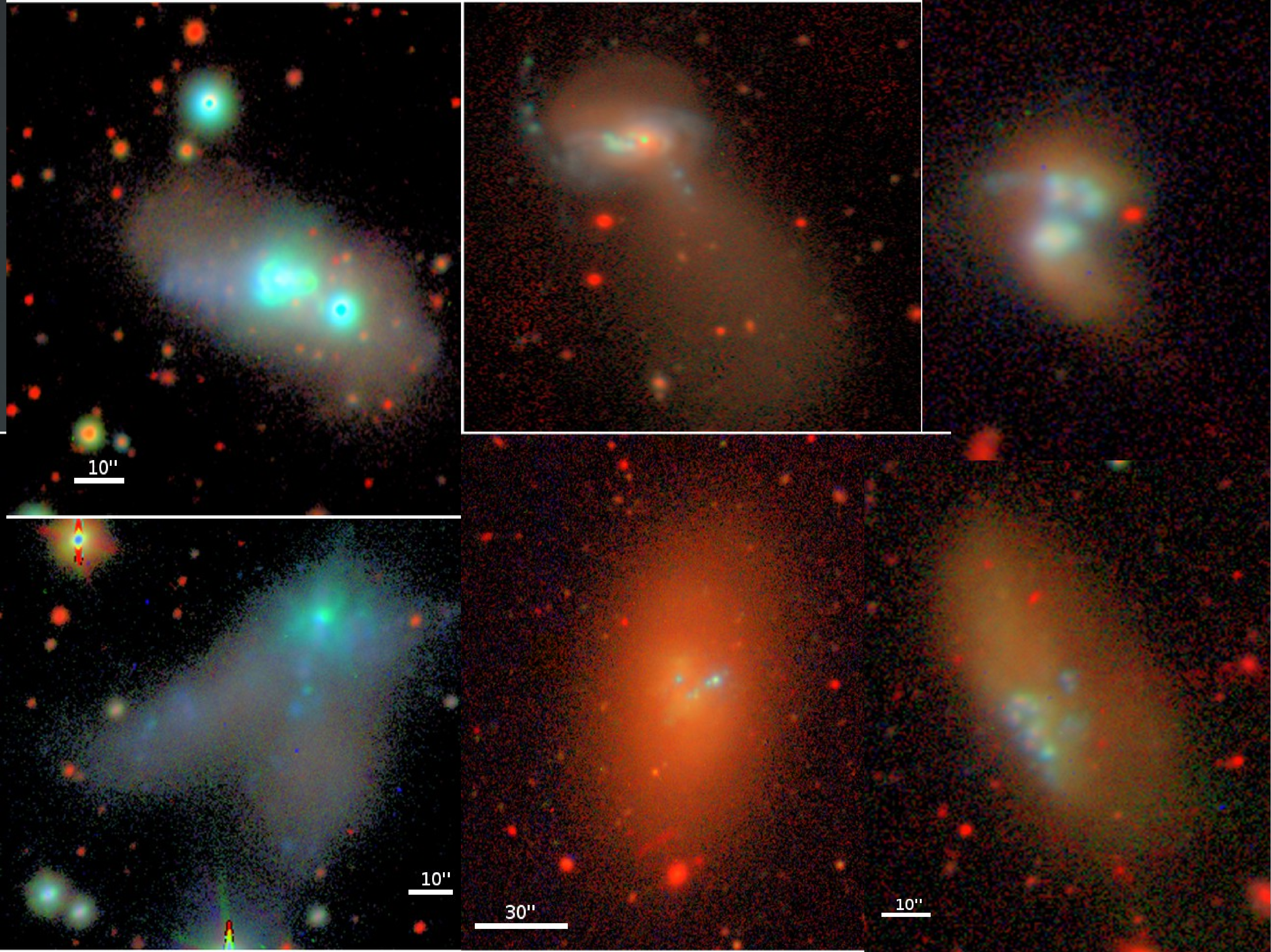
UBVRI HK

Southern & northern BCGs

High & low luminosity BCGs

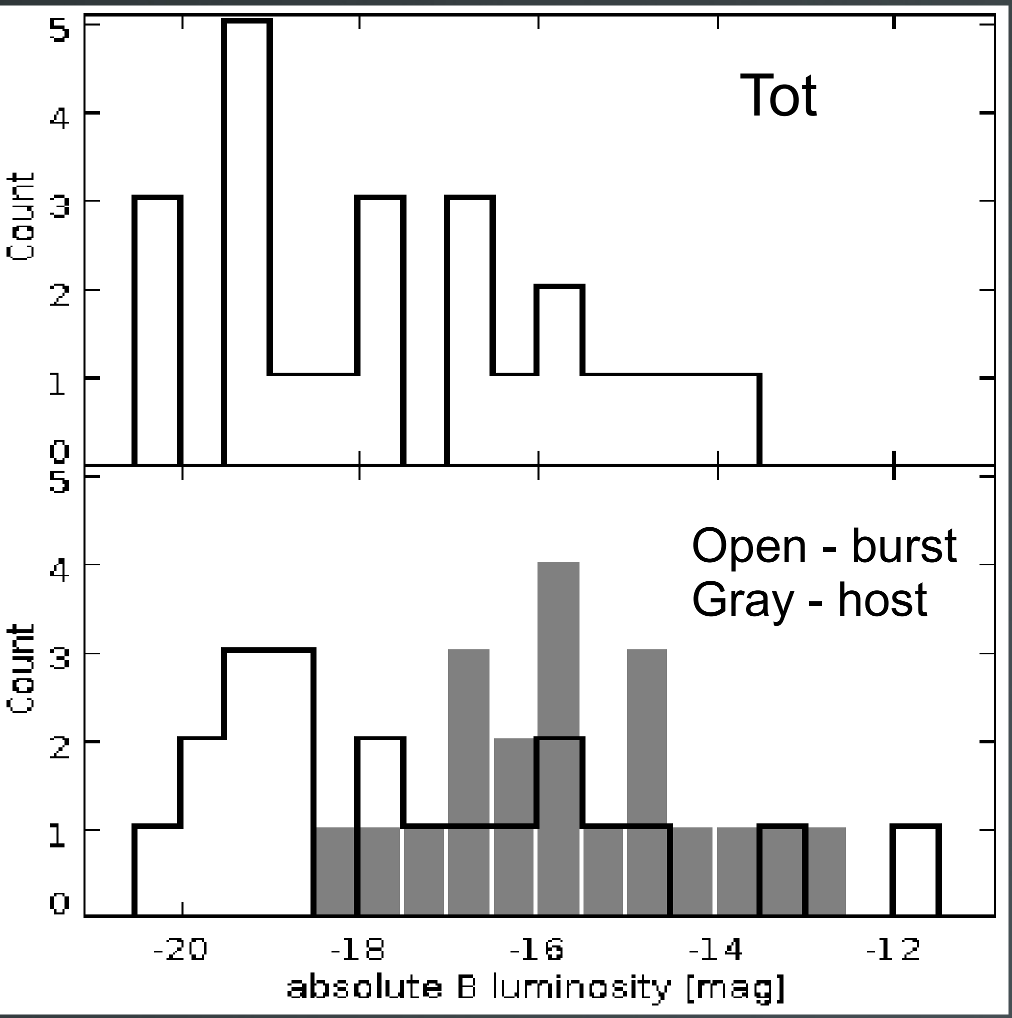
Micheva et al (2013a,b)



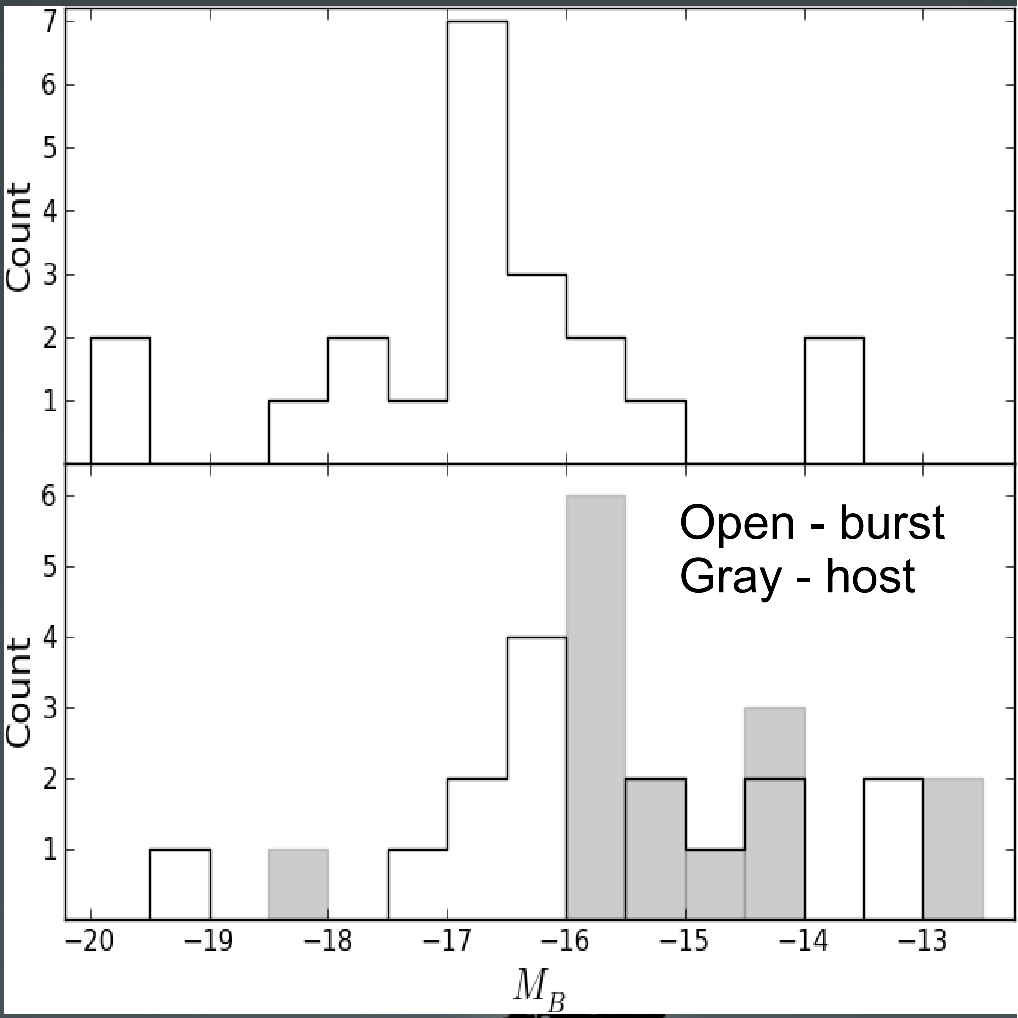

10''
10''
30''
10''

Total B luminosity

high luminosity BCGS



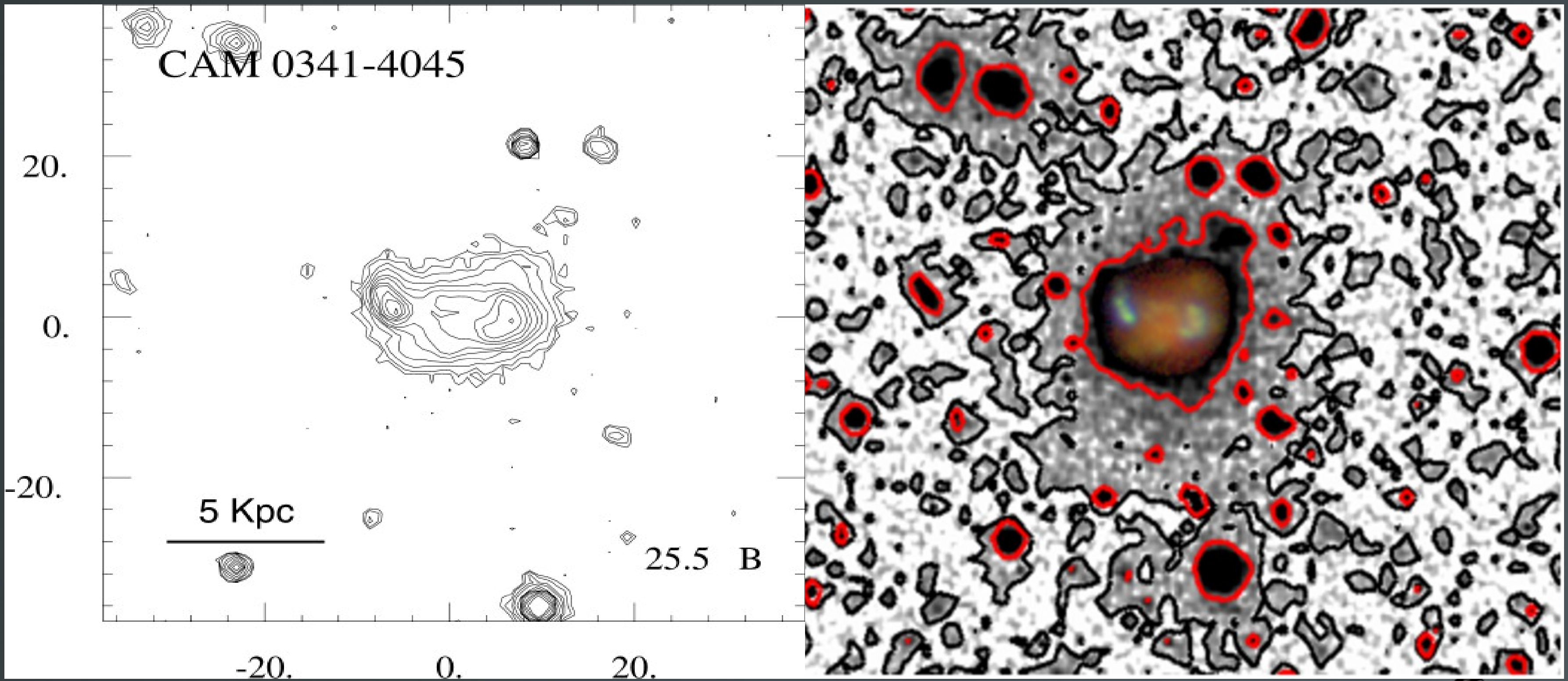
low luminosity BCGS



On average burst contributes ~3 mag to total luminosity

On average the burst increases the luminosity by ~1 mag.

We go deeper



Cairos et al. 2001

Micheva et al. 2013a

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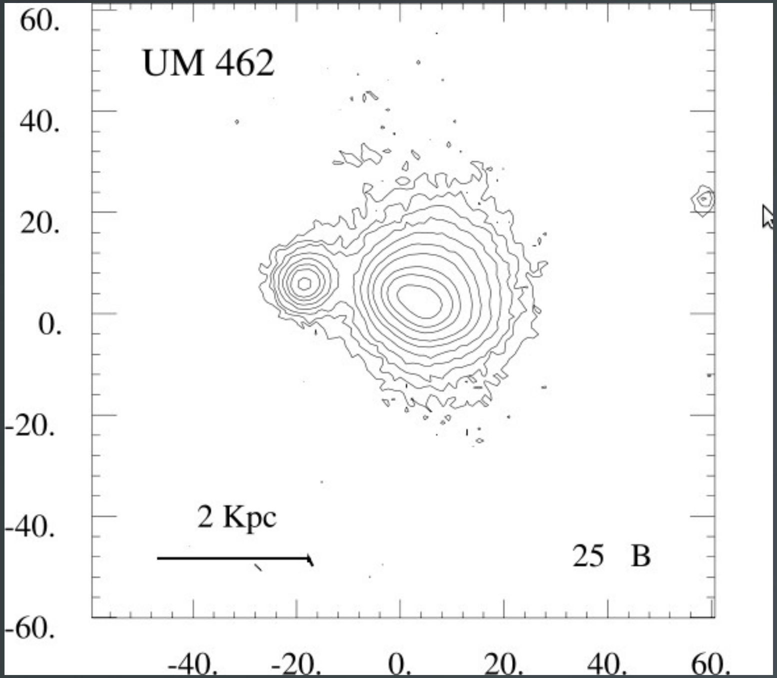
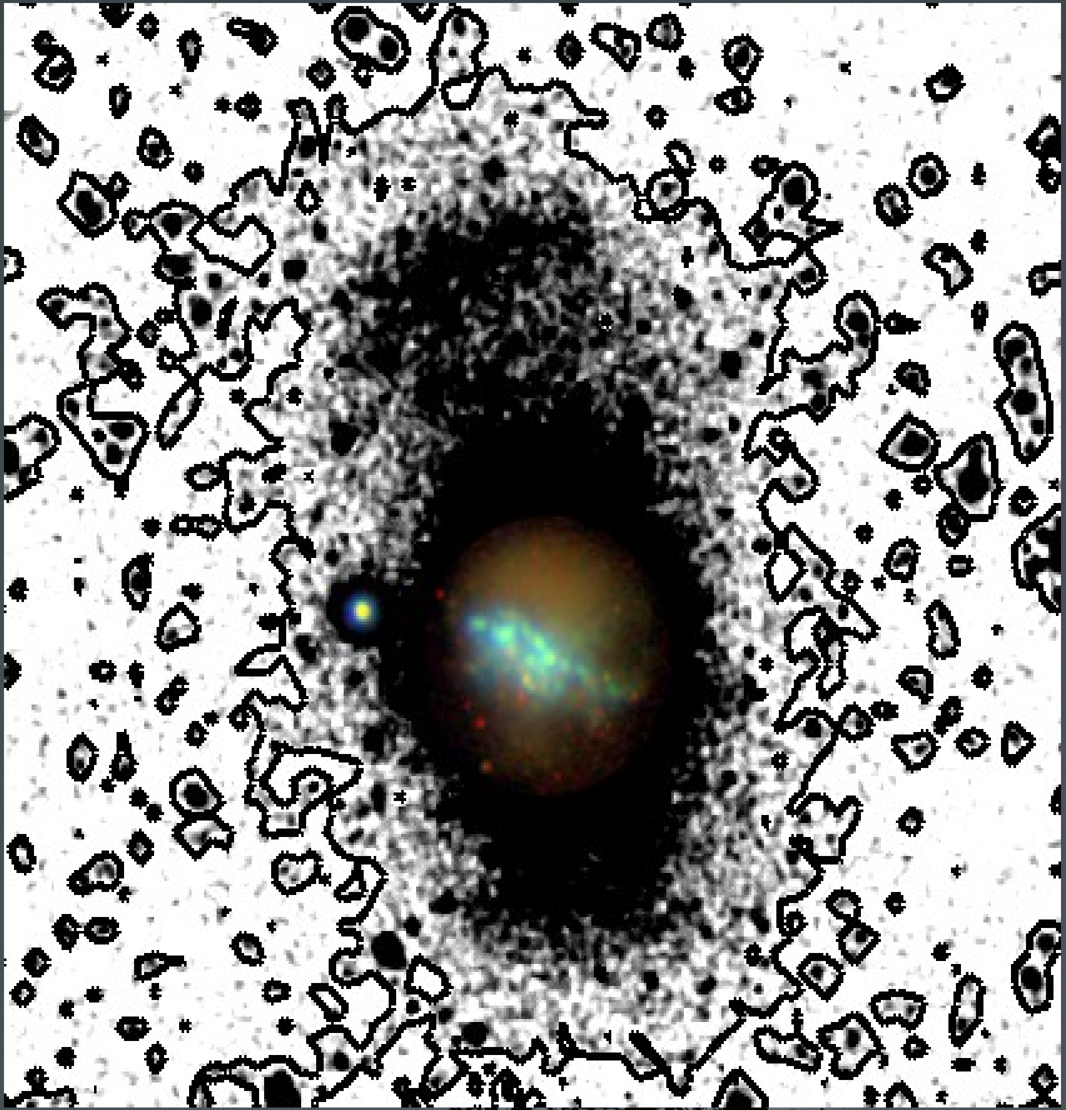
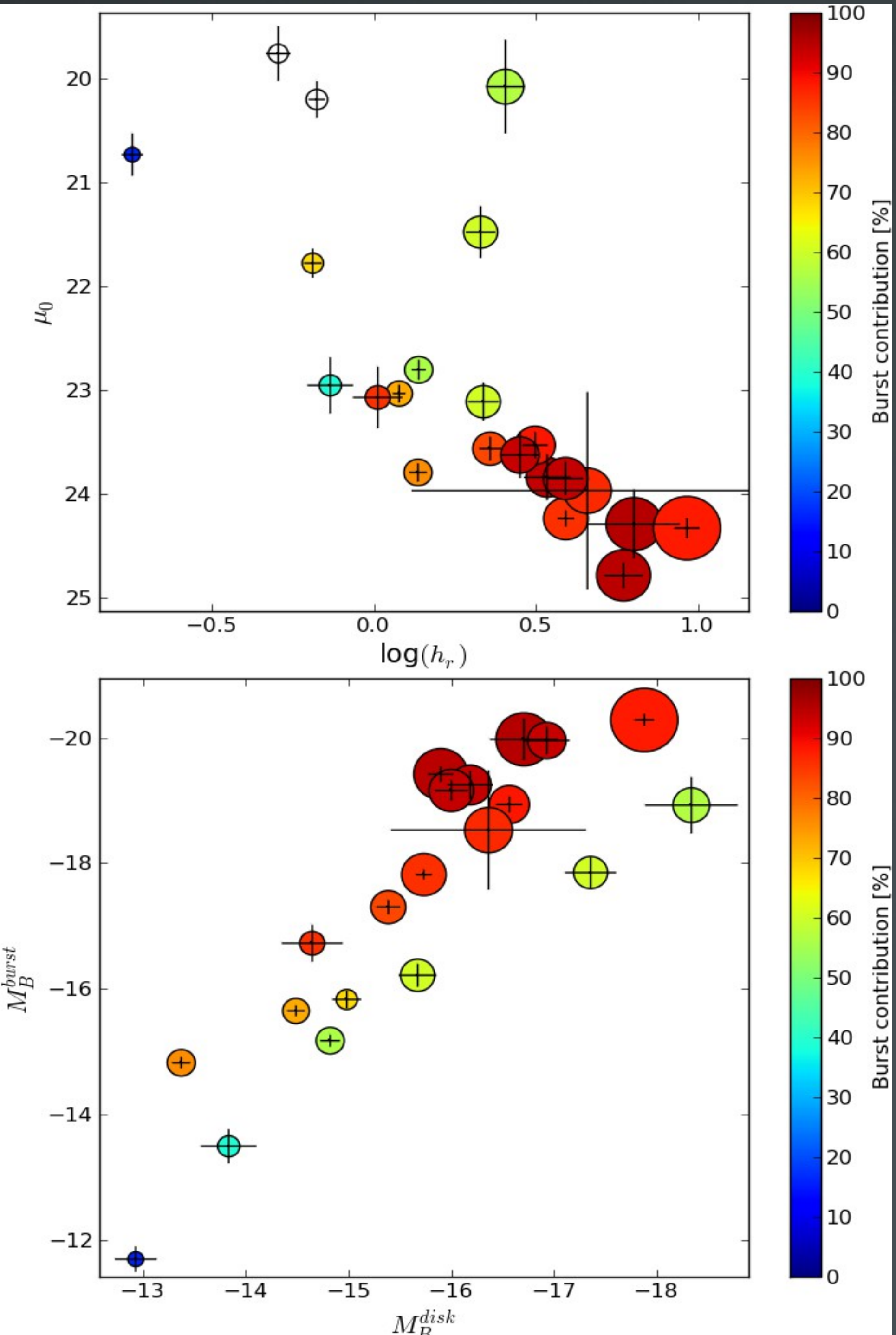


Cairos et al. 2001



Micheva et al. 2013b

SAMPLE 1 +(high lum)



- μ_0 vs h_r
- M_B^{burst} vs M_b^{host}
- Color coding: burst contribution
- Size coding: h_r

➔ Extended → lower μ_0

➔ Extended → stronger burst

➔ Brightest host ≠ strongest burst

➔Lines of constant burst contr.?

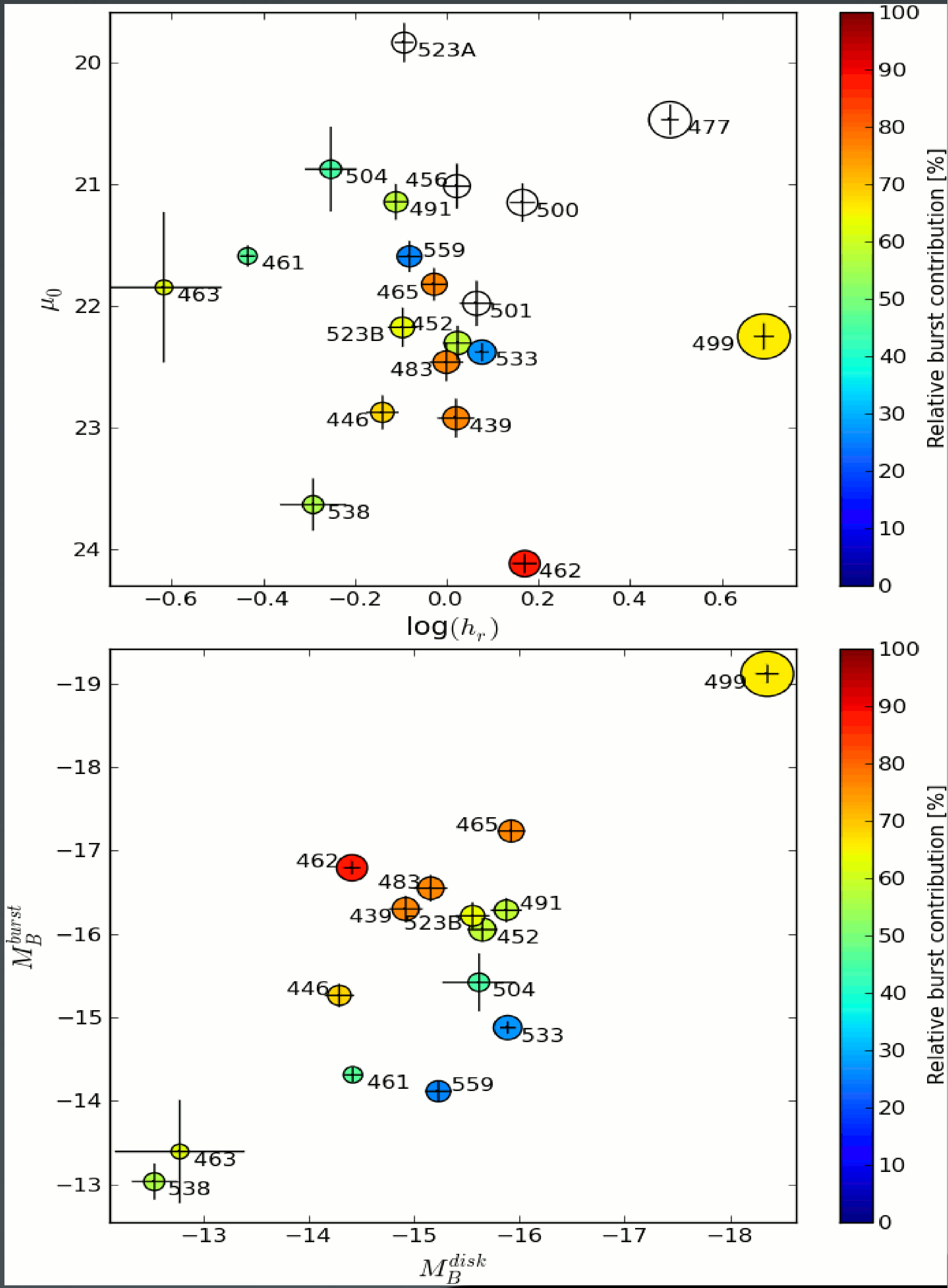
SAMPLE 2 (+low lum)

- μ_0 vs h_r
- M_B^{burst} vs M_b^{host}
- Color coding: burst contribution
- Size coding: h_r

→No correlation h_r => μ_0

→Most are compact, low M_B but high μ_0

→Not SF dominated

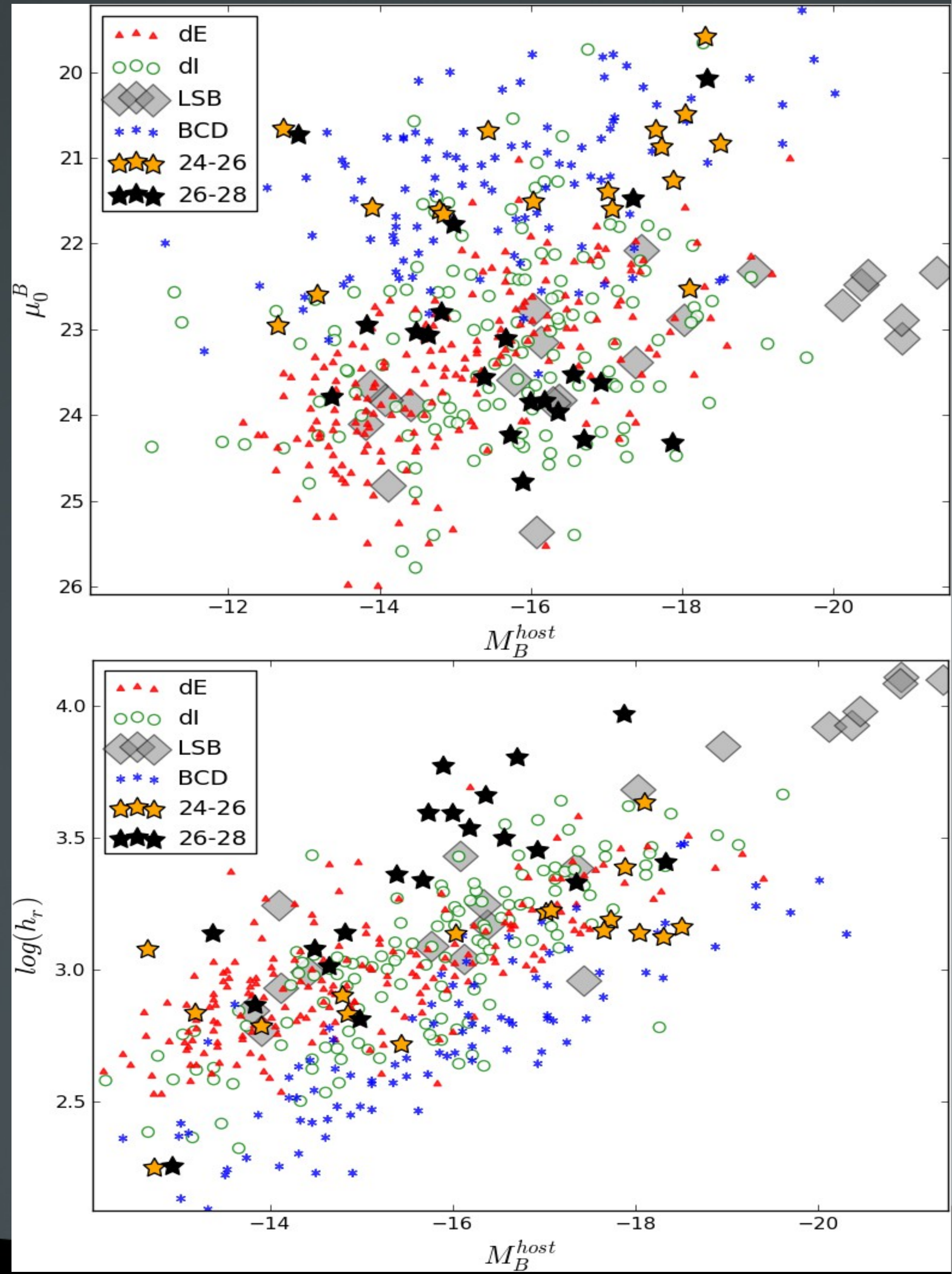


SAMPLE 1 (+high lum)

μ_0 vs M_B^{host}
h_r vs M_B^{host}

h_r & μ_0 from μ_B=24-26 mag arcsec^{-2}
⟶consistent with BCD from the literature

h_r & μ_0 from μ_B=26-28 mag arcsec^{-2}
⟶consistent with dE, dI, and LSBG



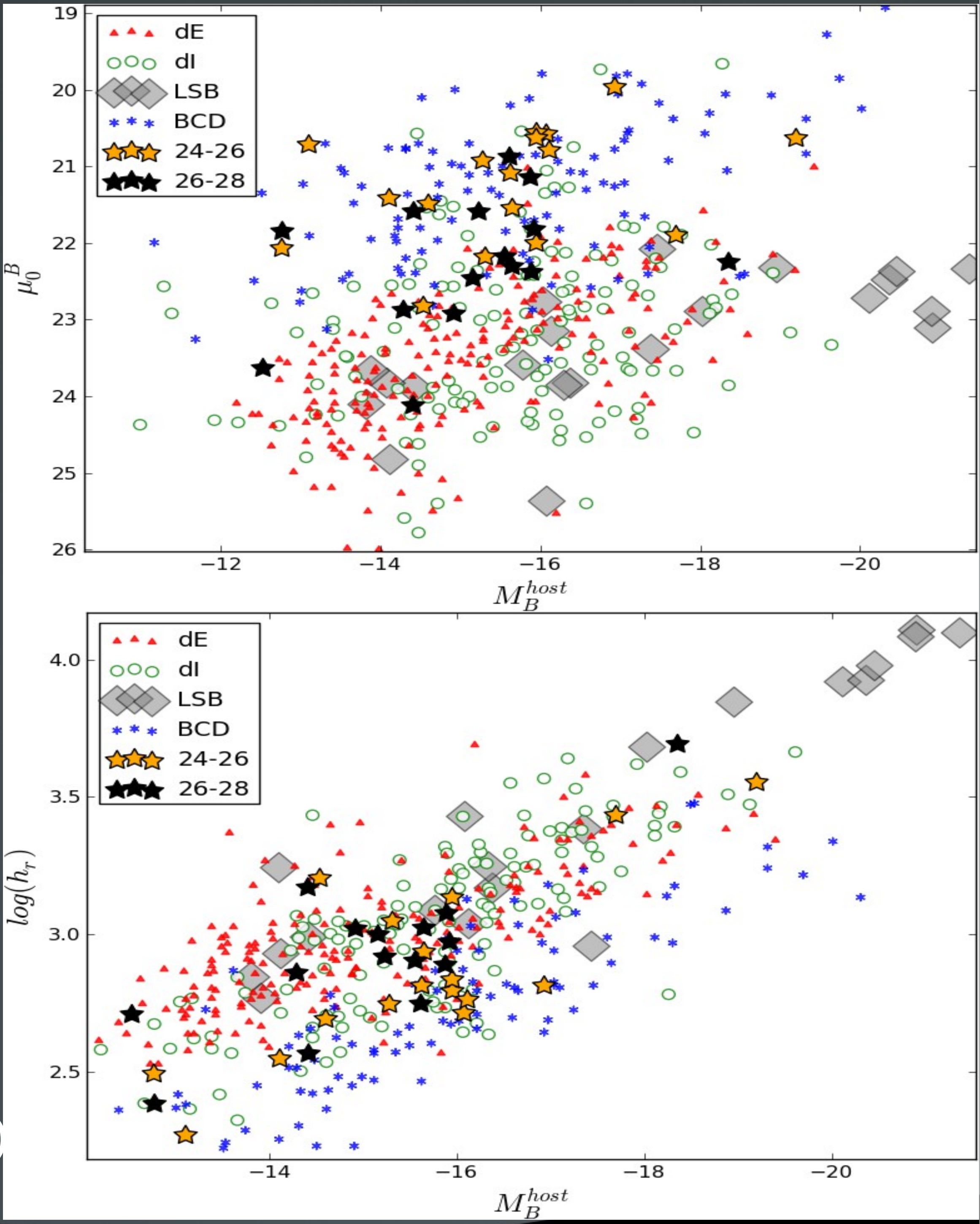
dE, dI, BCDs from Papaderos et al. (2008); giant LSBGs from Sprayberry et al. (1995)

SAMPLE 2 (+low lum)

μ_0 vs M_B^{host}
h_r vs M_B^{host}

h_r & μ_0 from both
μ_B=24-26 mag arcsec^{-2}
and μ_B=26-28 mag arcsec^{-2}

$\longrightarrow$consistent with BCD from the literature



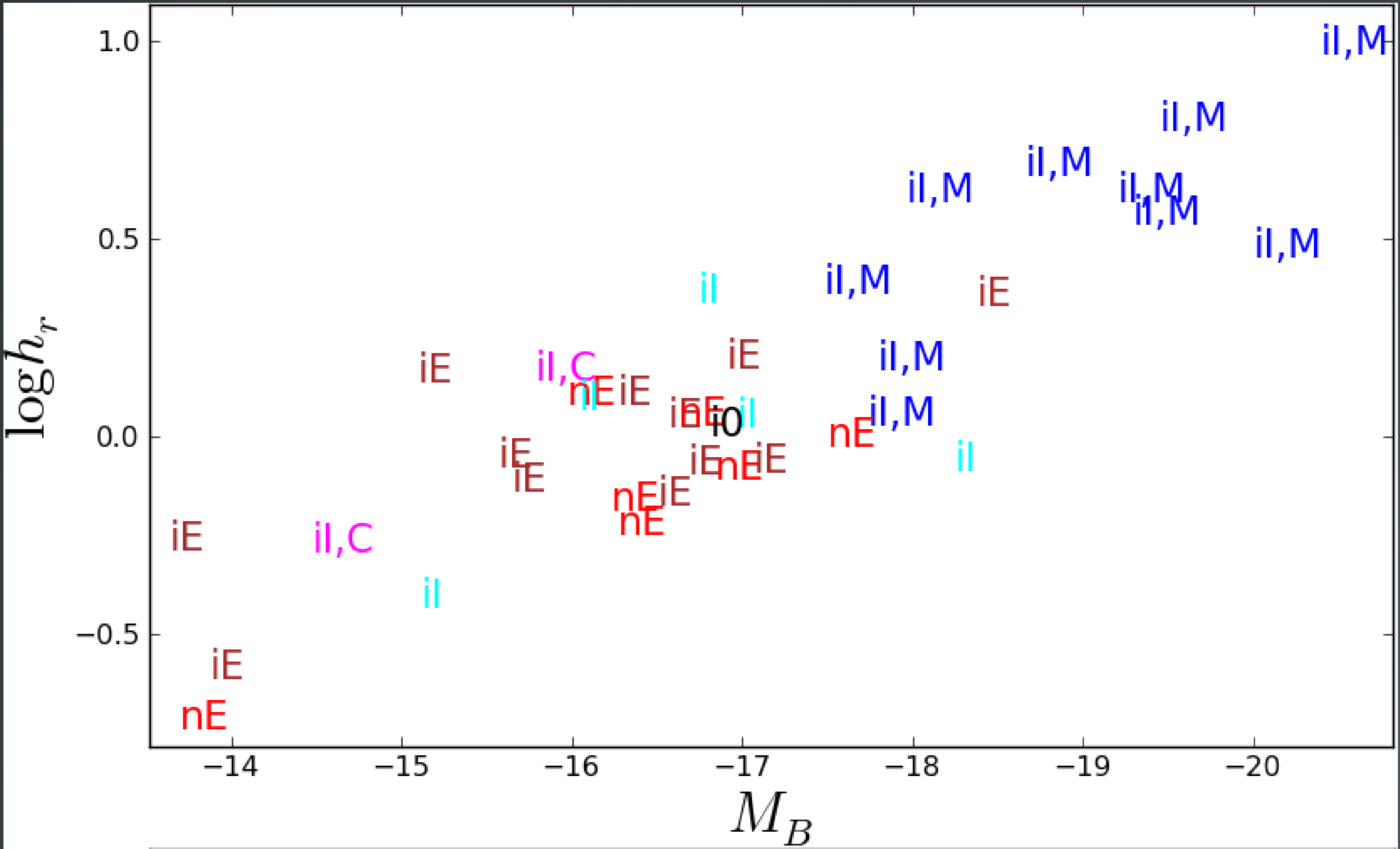
dE, dI, BCDs from Papaderos et al. (2008)
giant LSBGs from Sprayberry et al. (1995)

Low vs High luminosity BCGs

- Behave in different ways
  1. Dynamically young luminous irregular galaxies
  2. Fainter objects, regular outer isophotes

  (Telles et al 1997)

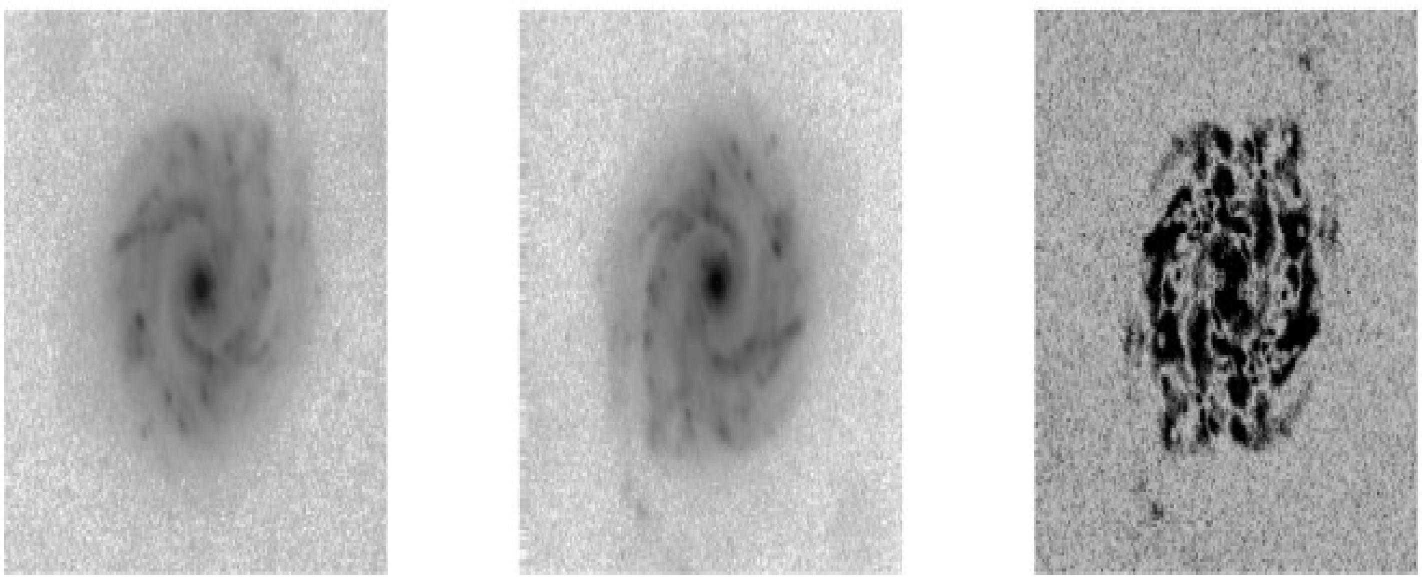
- Different progenitors/evolution histories



Color coding: morphological class

Asymmetry

Morphology reveals dynamical history:
mergers/interactions or lack thereof.



I R abs(I–R)

$$A = \frac{\mathrm{abs}(I-R)}{I}$$

ϕ=180

What contributes to the asymmetry?

“Flocculent” component: due to star formation

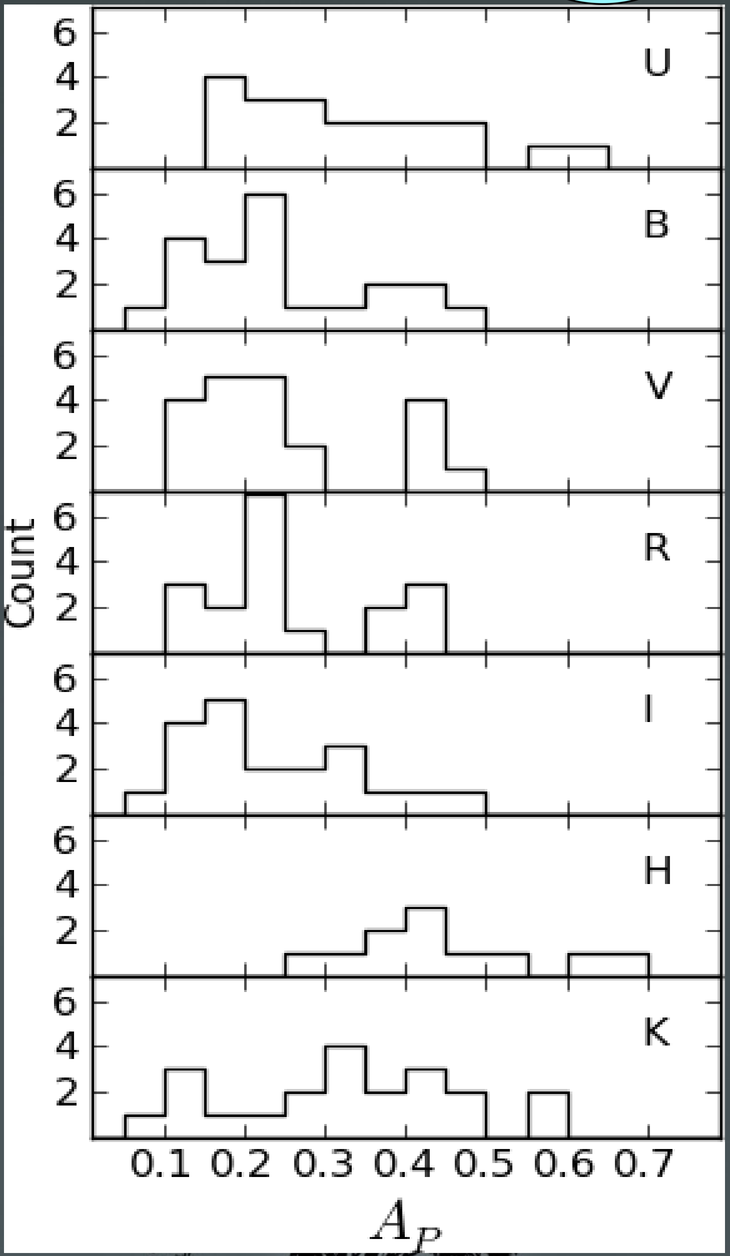
“Dynamical” component: due to merger, tidal interaction

(Conselice et al. 2000)

Petrosian Asymmetry

Minimum, ϕ=180

- Radius r(η[0.2])
  - Small (~0.2) optical small NIR A_P – nE BCGs
  - Small optical large NIR A_P – iE BCGs
  - Large (~0.4) optical large NIR A_P – iI BCGs
- Optical A dominated by star formation regions (a.k.a. “flocculent” component)

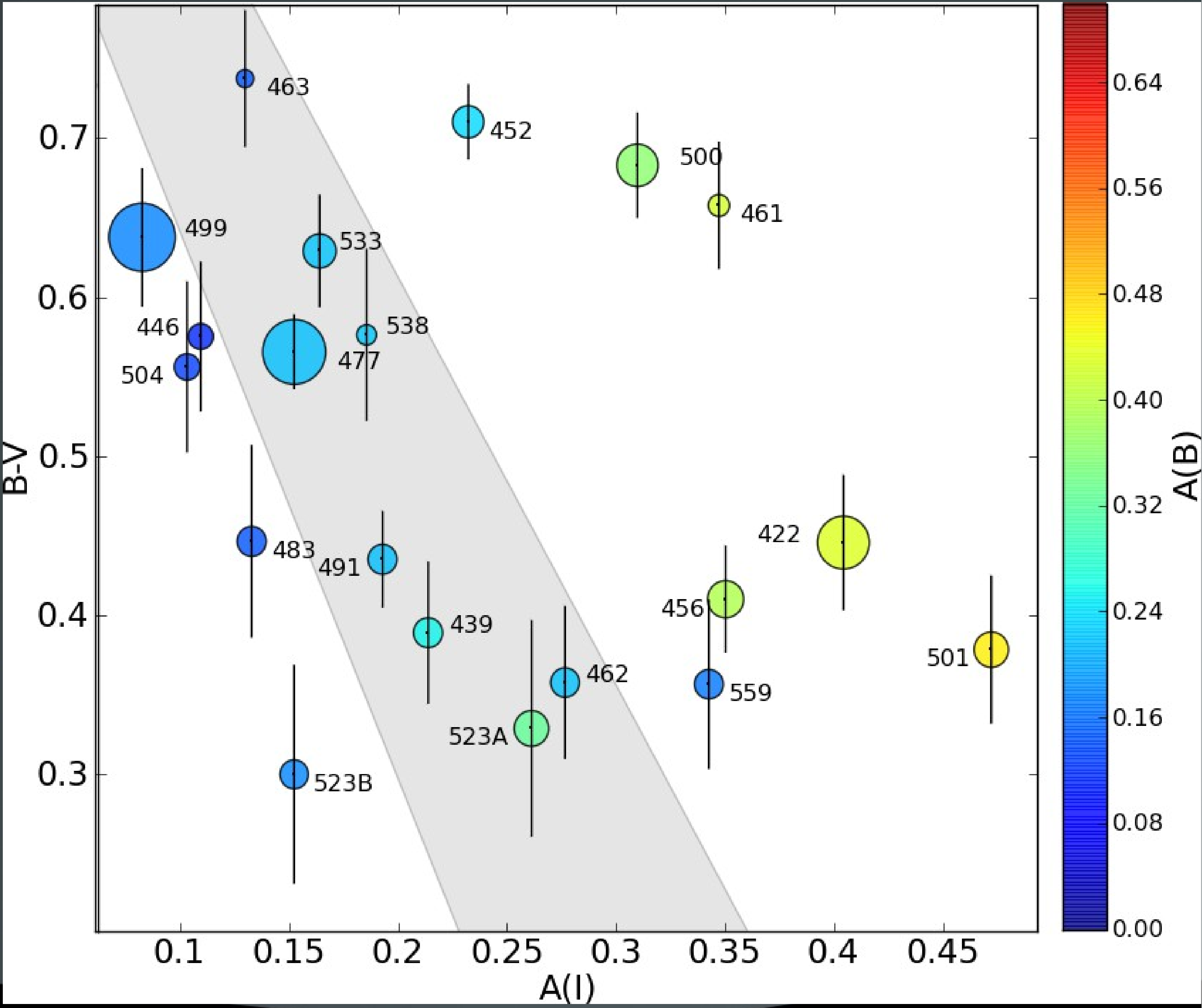


Sample 2

Identifying mergers

SAMPLE 2

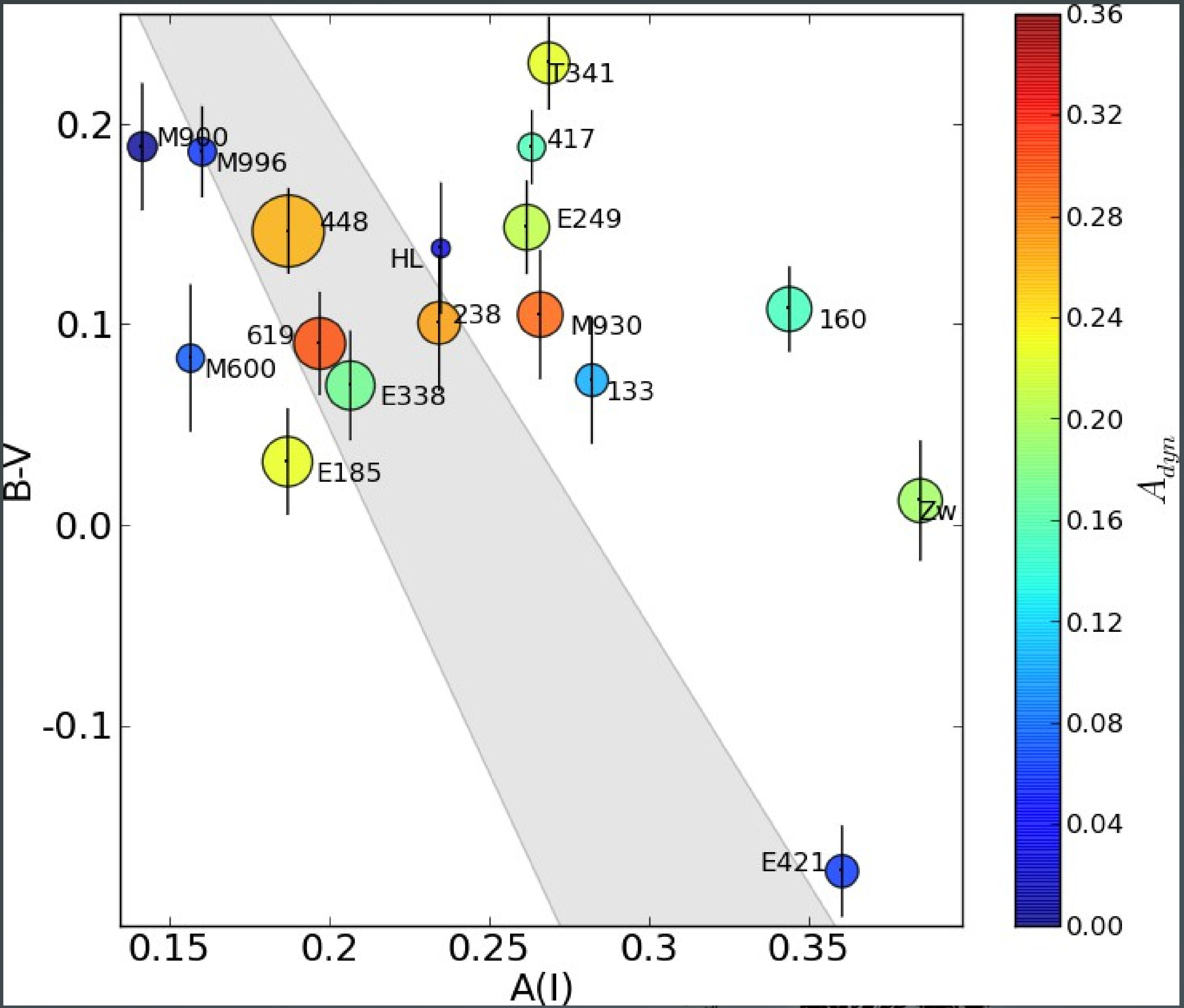
- B-V vs Petrosian A (R or I band)
- Fiducial color-asymmetry sequence (Conselice et al. 2000)
- Color coding: Petrosian A (blue)
- Size coding: h_r



Identifying mergers

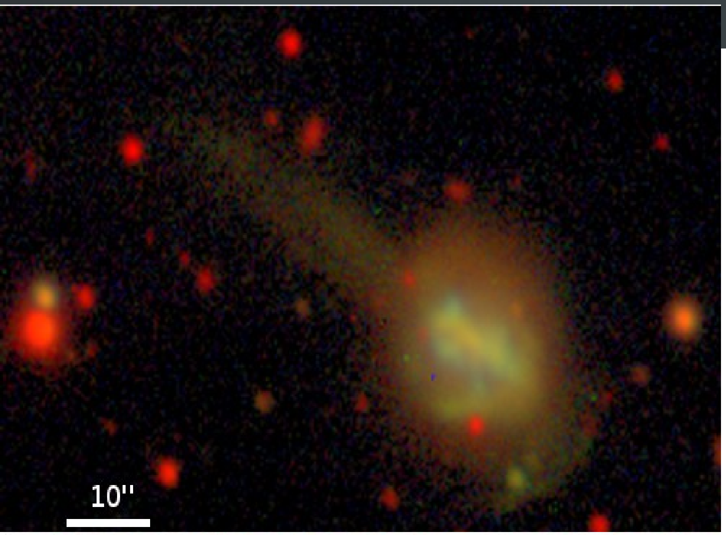
SAMPLE 1

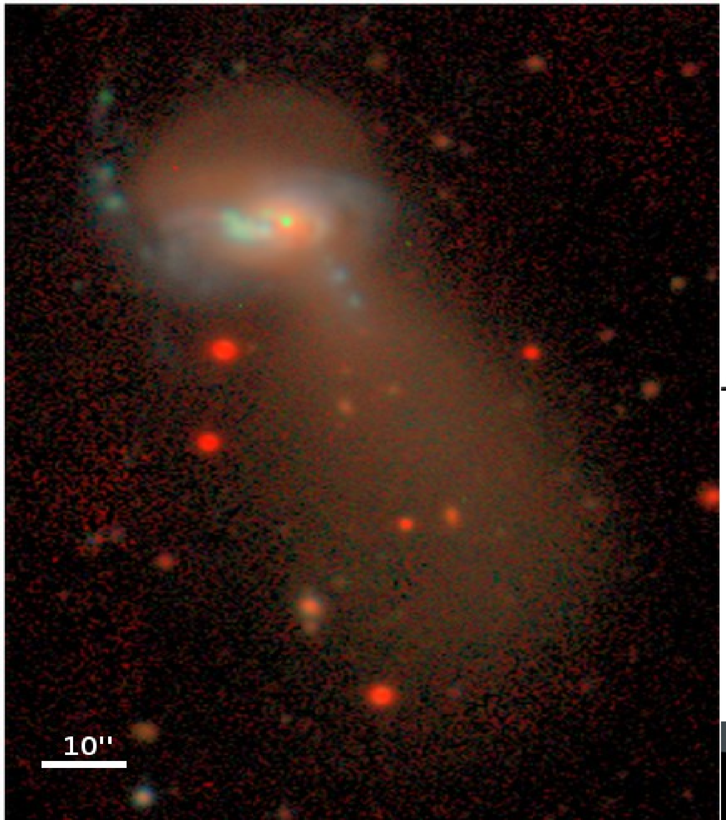
- B-V vs Petrosian A
- Fiducial color-asymmetry sequence (Conselice et al. 2000)
- Size coding: h_r

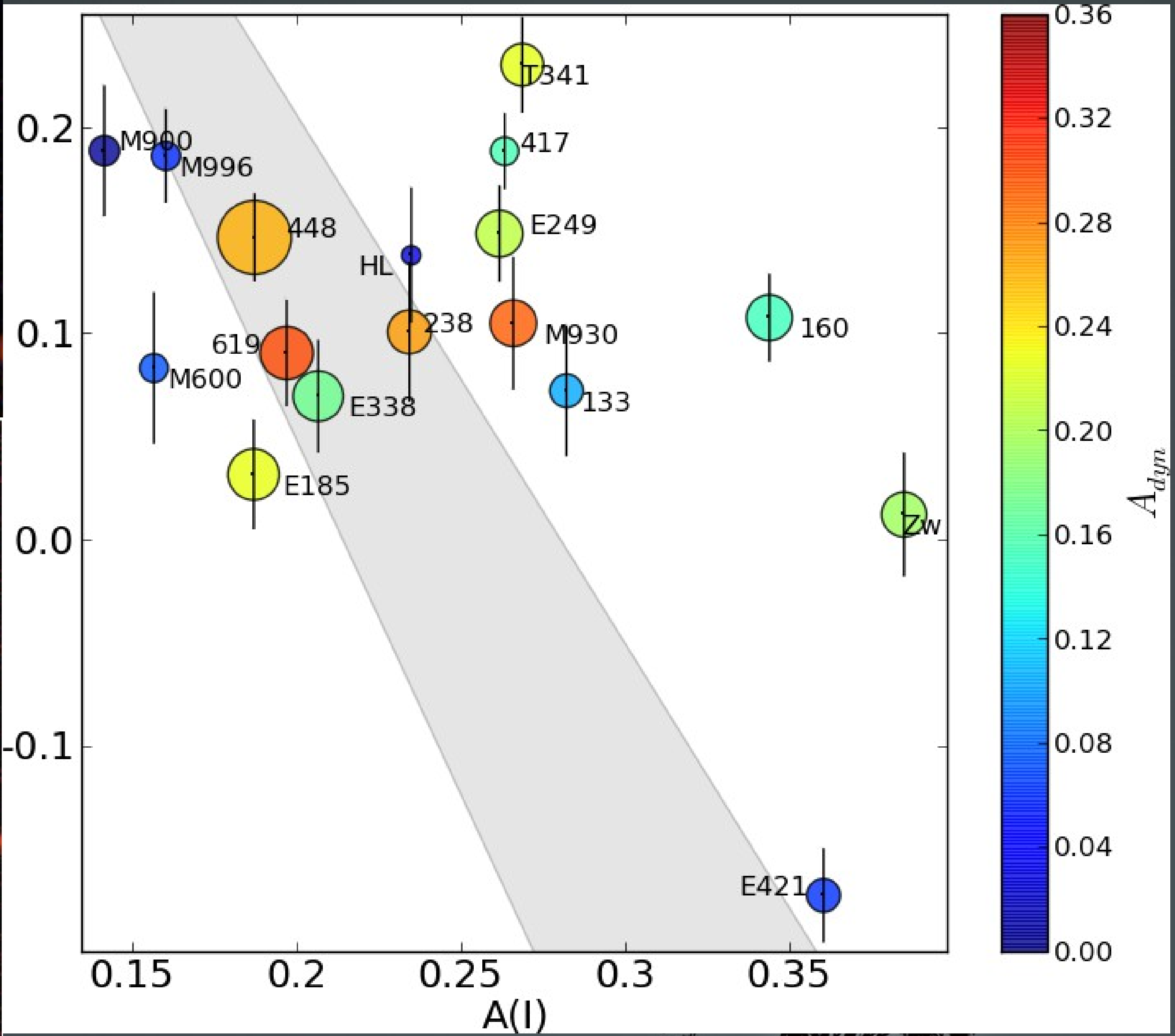


Identifying mergers

SAMPLE 1



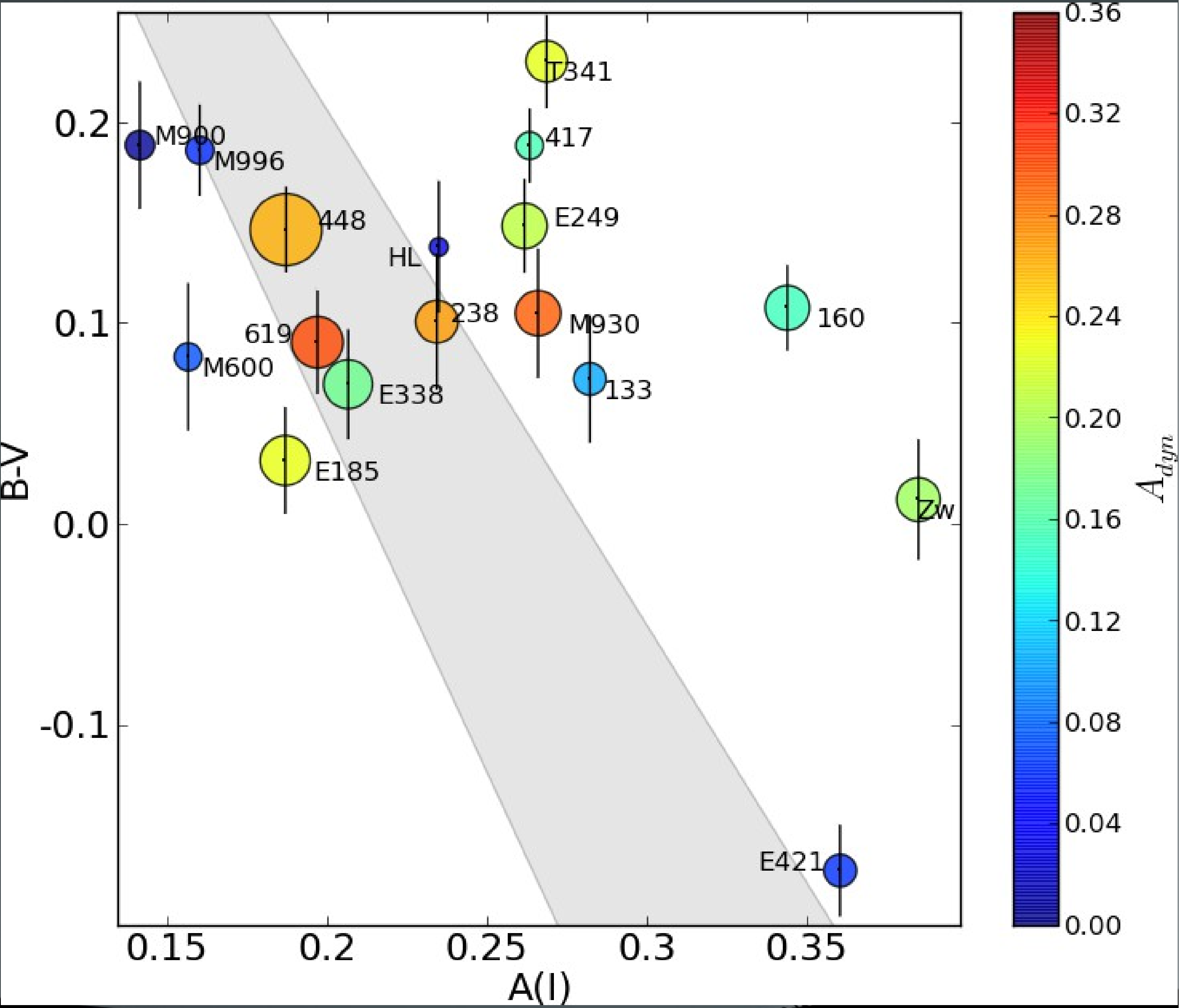




The dynamical component

- Starburst is in the way => mask it out
- $\mu_{Opt} \leq 25$ mag arcsec^{-2} set to 25
- $\mu_{NIR} \leq 21$ mag arcsec^{-2} set to 21

  Smoothed by 1x1 kpc
- Color coding: dynamical asymmetry

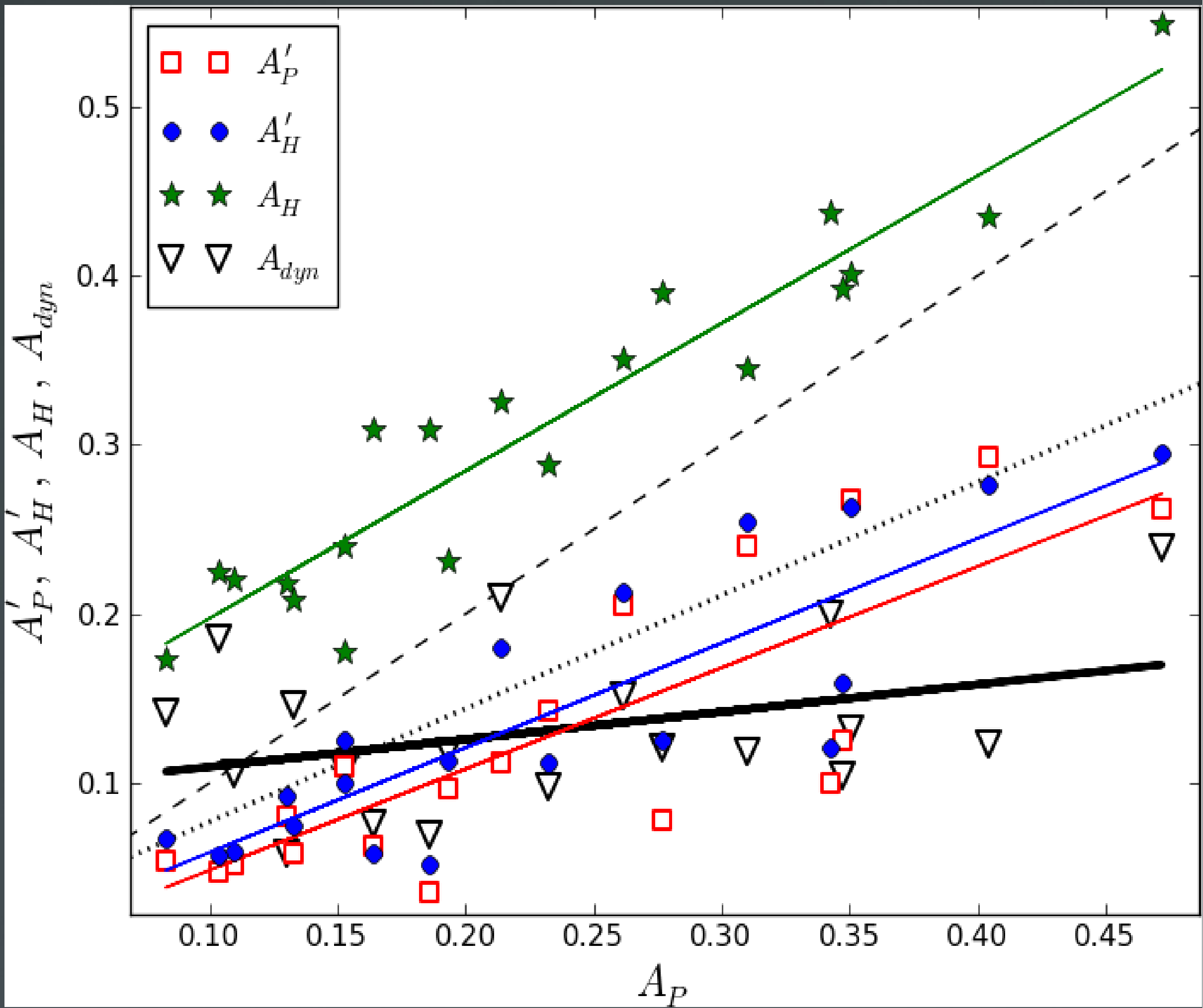


Asymmetry correlations

Sample 2

$A_H'(I) = 0.62 \times A_P - 0.003$

Normal galaxies:
$A_G' = 0.67 \times A_P + 0.01$
(Conselice 2003)

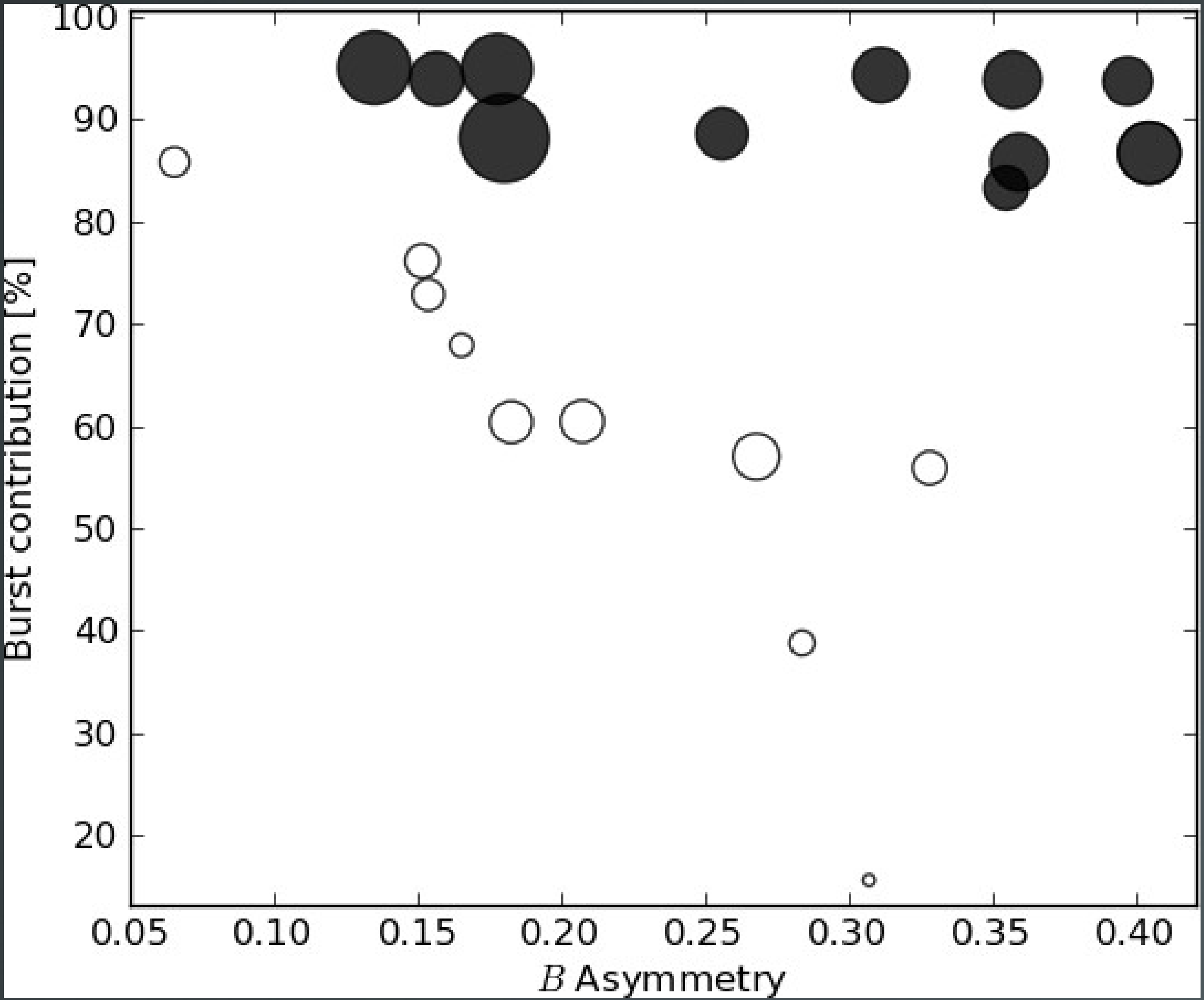


Dotted line: Conselice 2003 for normal galaxies

A_p – Petrosian asym.
A_p' – Petrosian asym, filtered
A_H – Holmberg asym
A_H' – Holmberg asym, filtered
A_{dyn} – Dynamical asym, filtered

A_{dyn} does not correlate with A_p

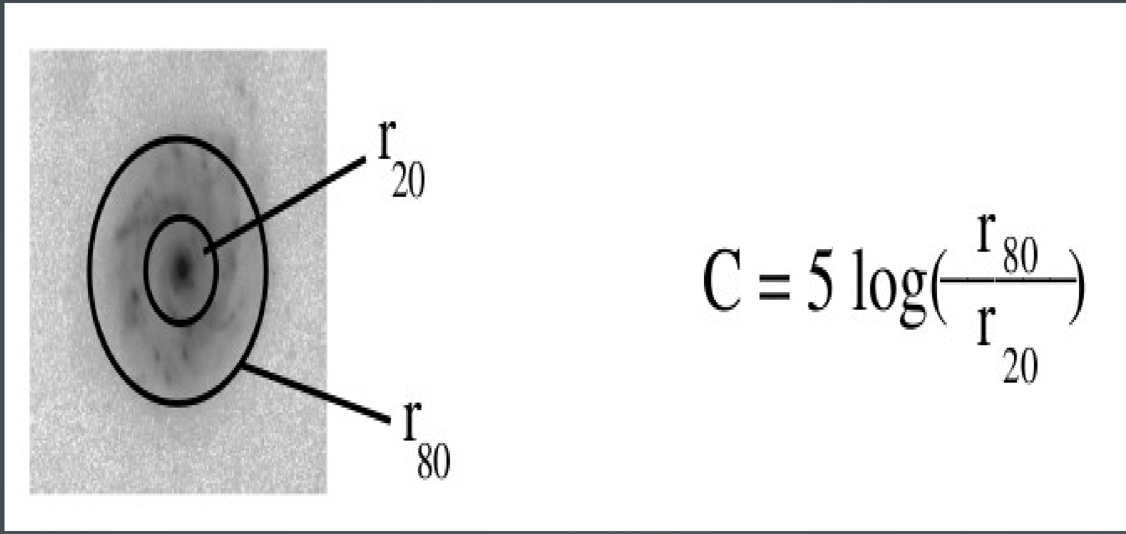
Sample 1



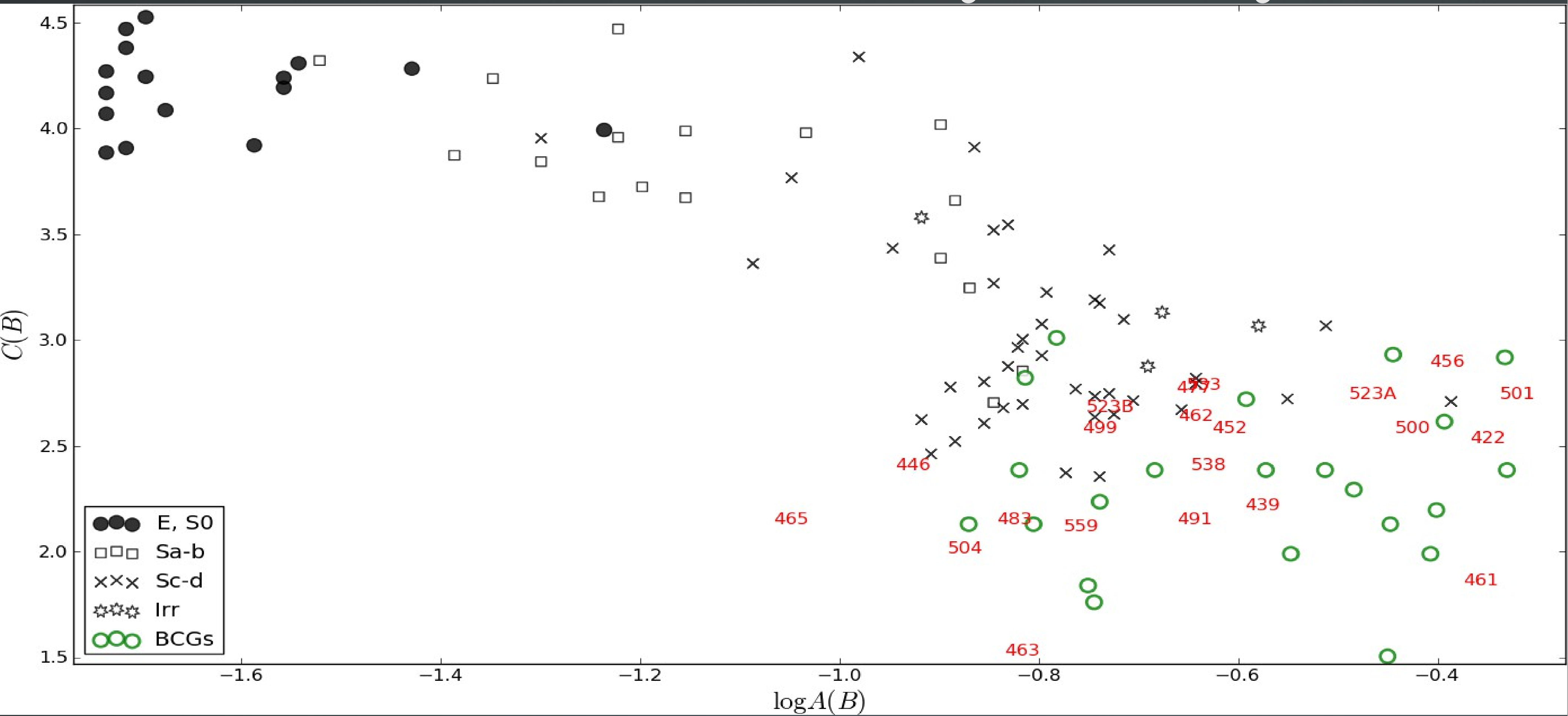
- Burst % vs A_P
- Size coding: h_r
- Black: μ_0, h_r consistent with giant LSBGs

Concentration

- R_{20} = 20% of growth cure
- R_{80}=80% of growth curve



Concentration vs Asymmetry



Normal galaxies from Conselice et al. 2000

BCGs/ELGs – large asymmetries, small concentration
Impossible to tell BCGs from ELGs

Conclusions

1. Low & high luminosity BCGs behave in distinctly different ways (structural parameters μ_B, h_r, A, but not C)

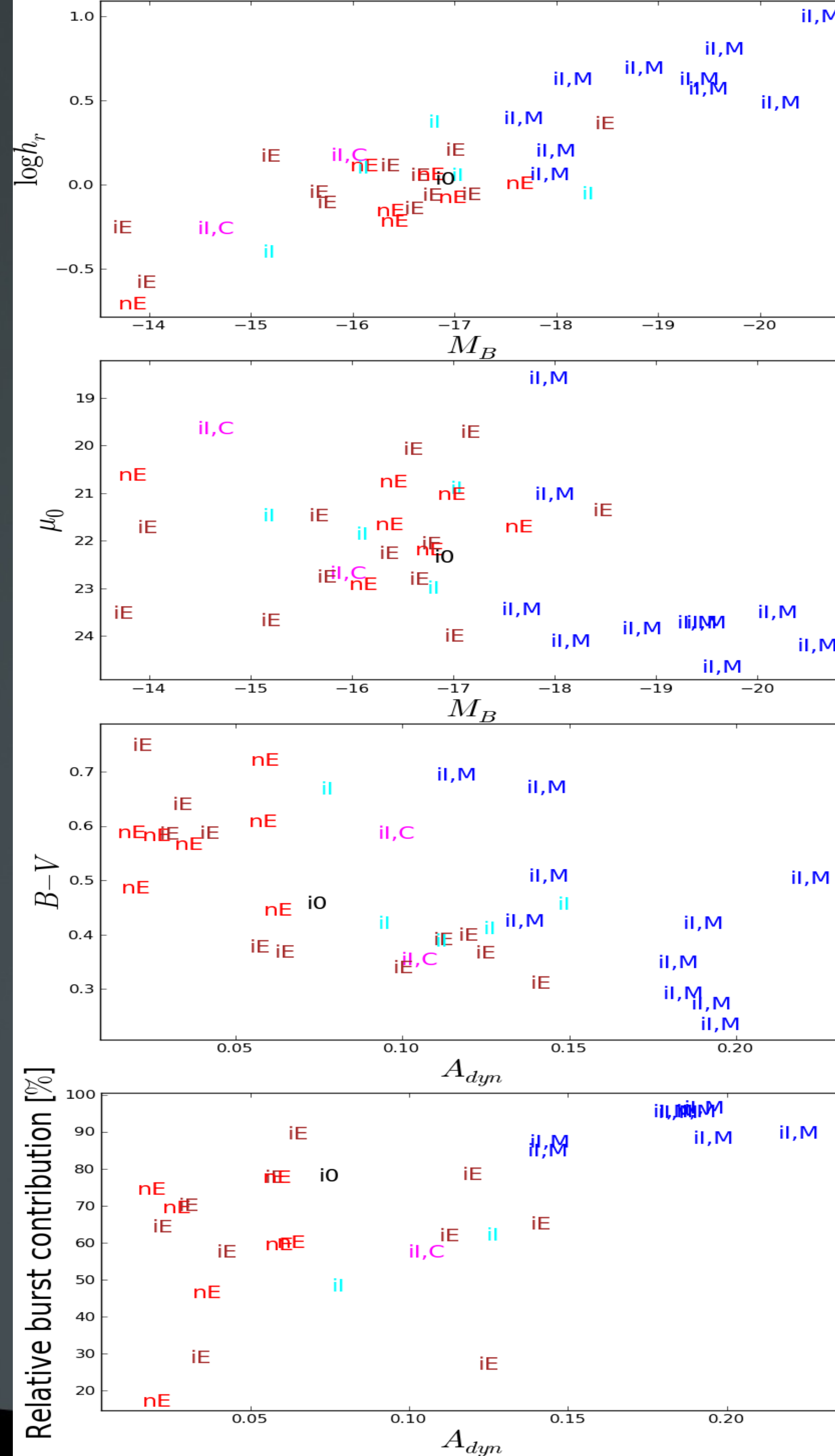
3. Tentative link to giant LSBGs as hosts of high luminosity BCGs

4. Dynamical asymmetry component catches mergers more successfully in high luminosity BCGs

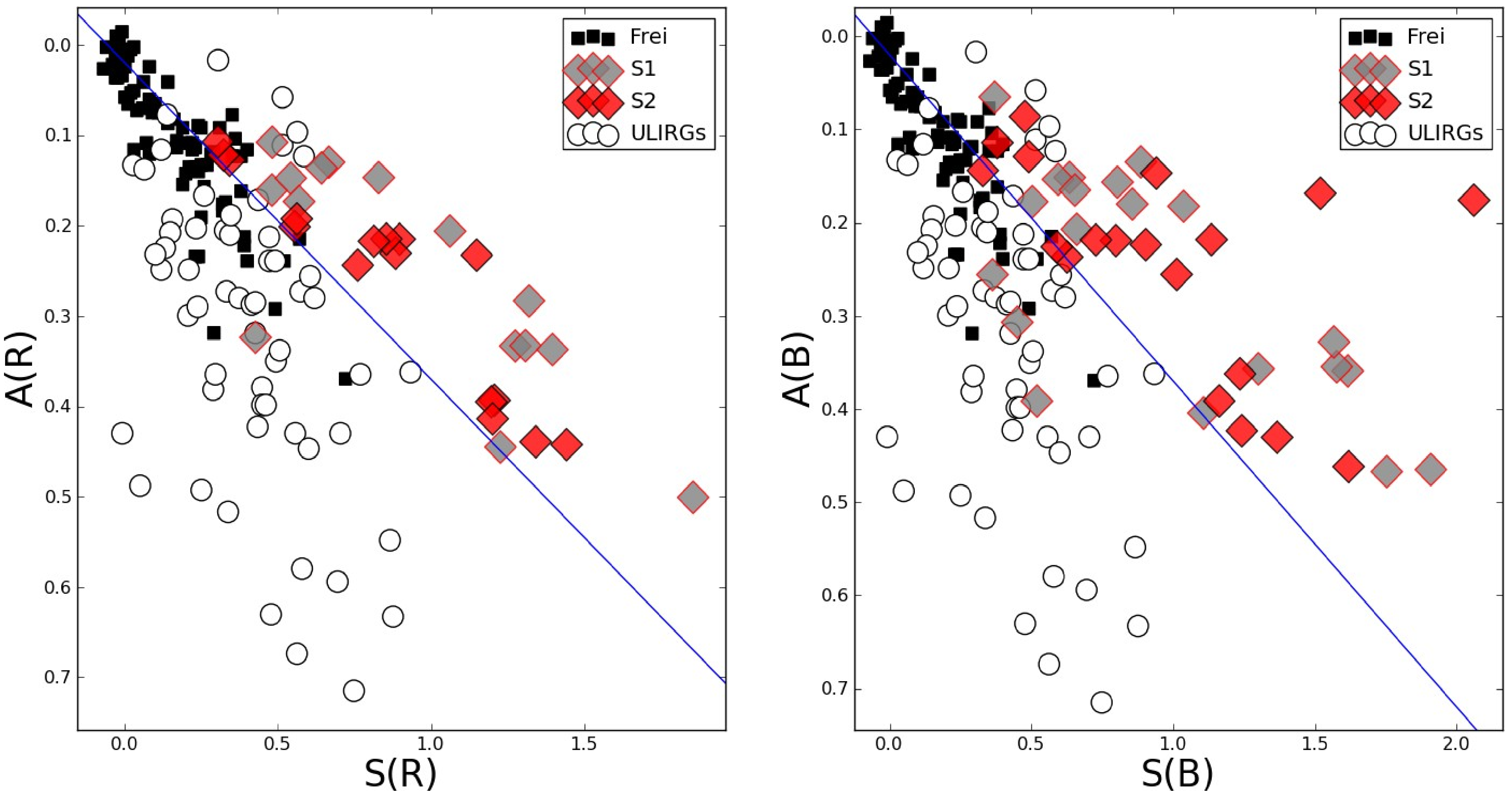
5. Change in optical/NIR asymmetry reflects morphological class

6. Optical Asym – an OK proxy for flocculent component; NIR Asym – good proxy for dynamical component

- h_r vs M_B
- μ_0 vs M_B
- B-V vs A_{dyn}
- Burst % vs A_{dyn}
- Color coding: morphological class

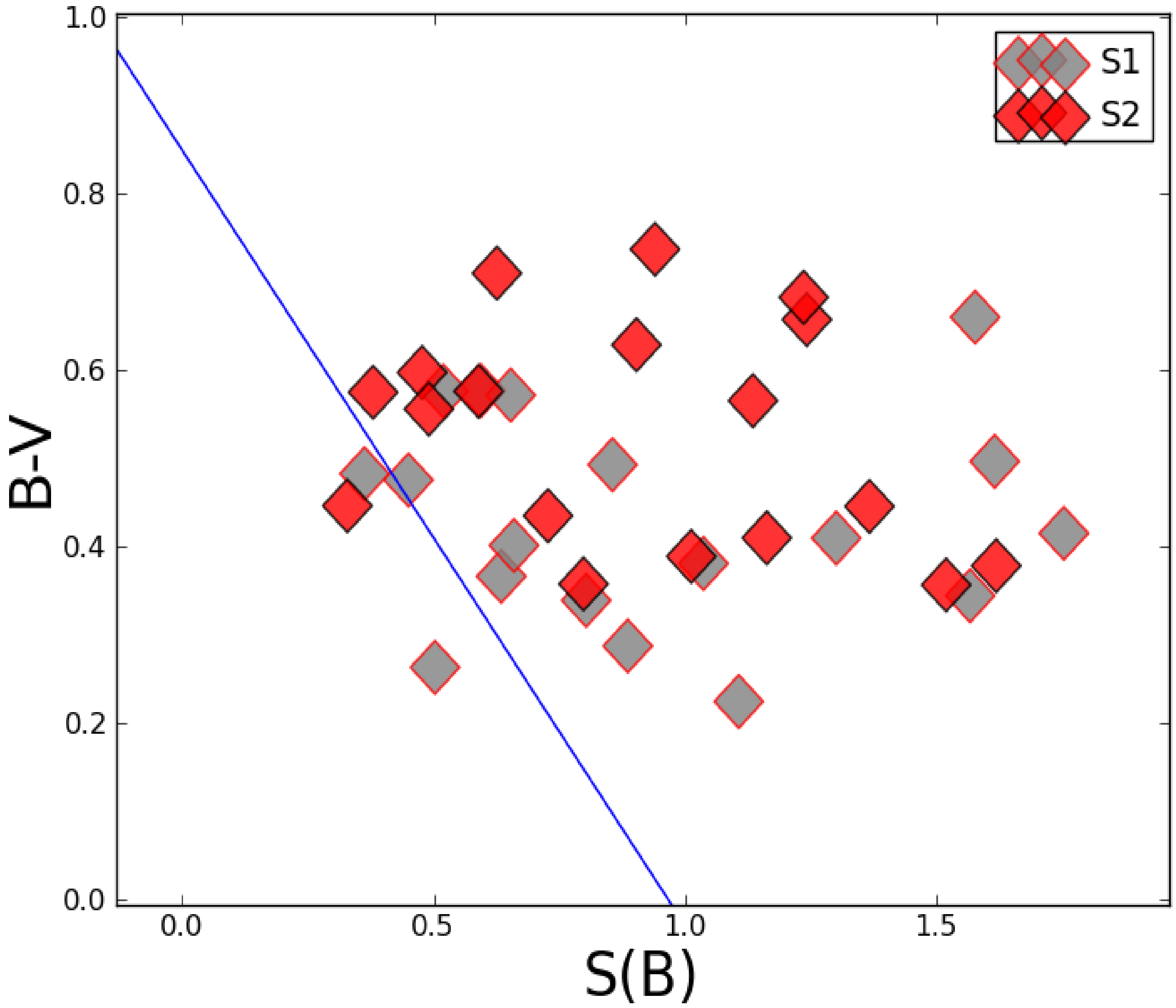


Clumpiness



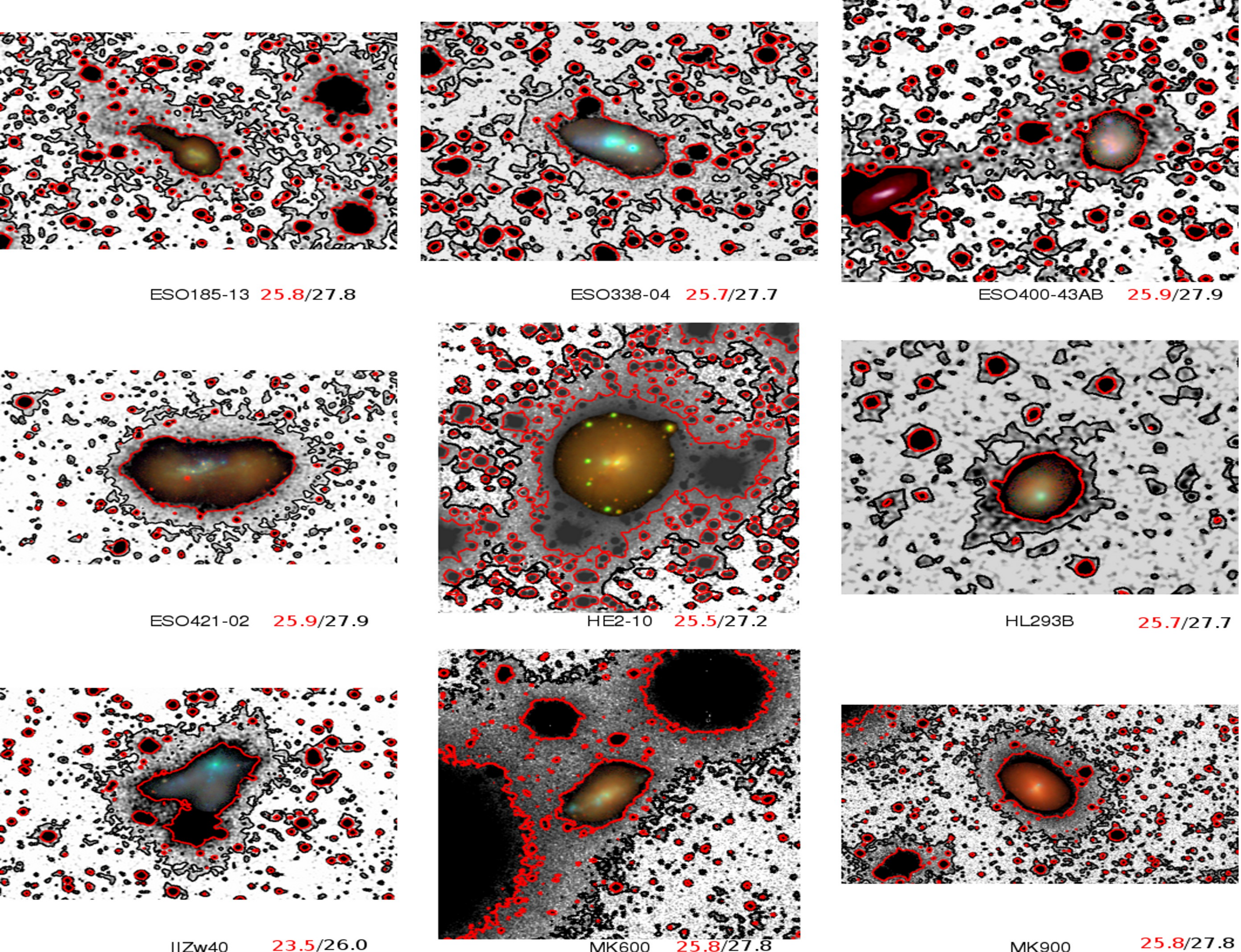
normal+ULIRGs (Conselice 2003)

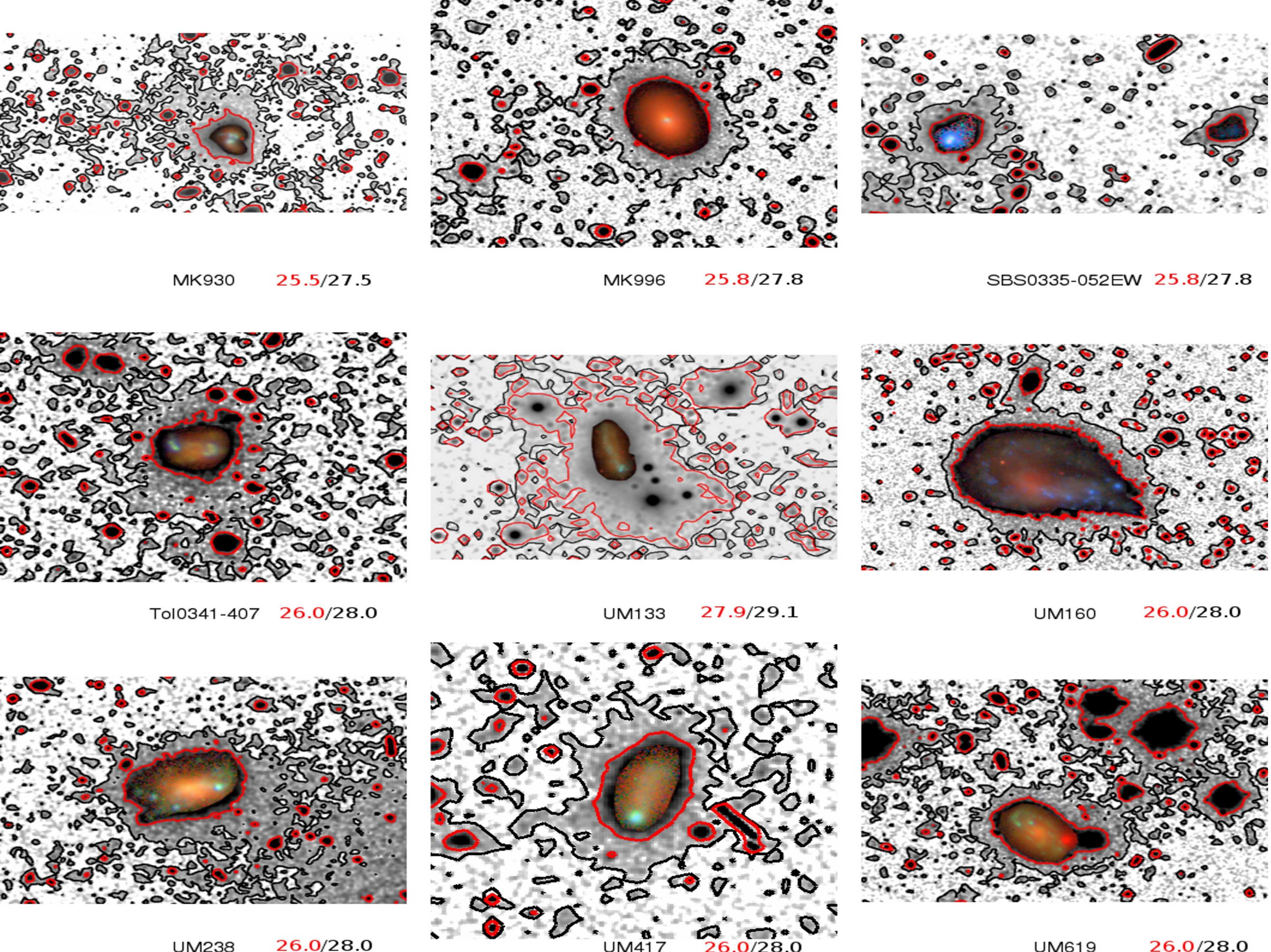
B-V vs. S

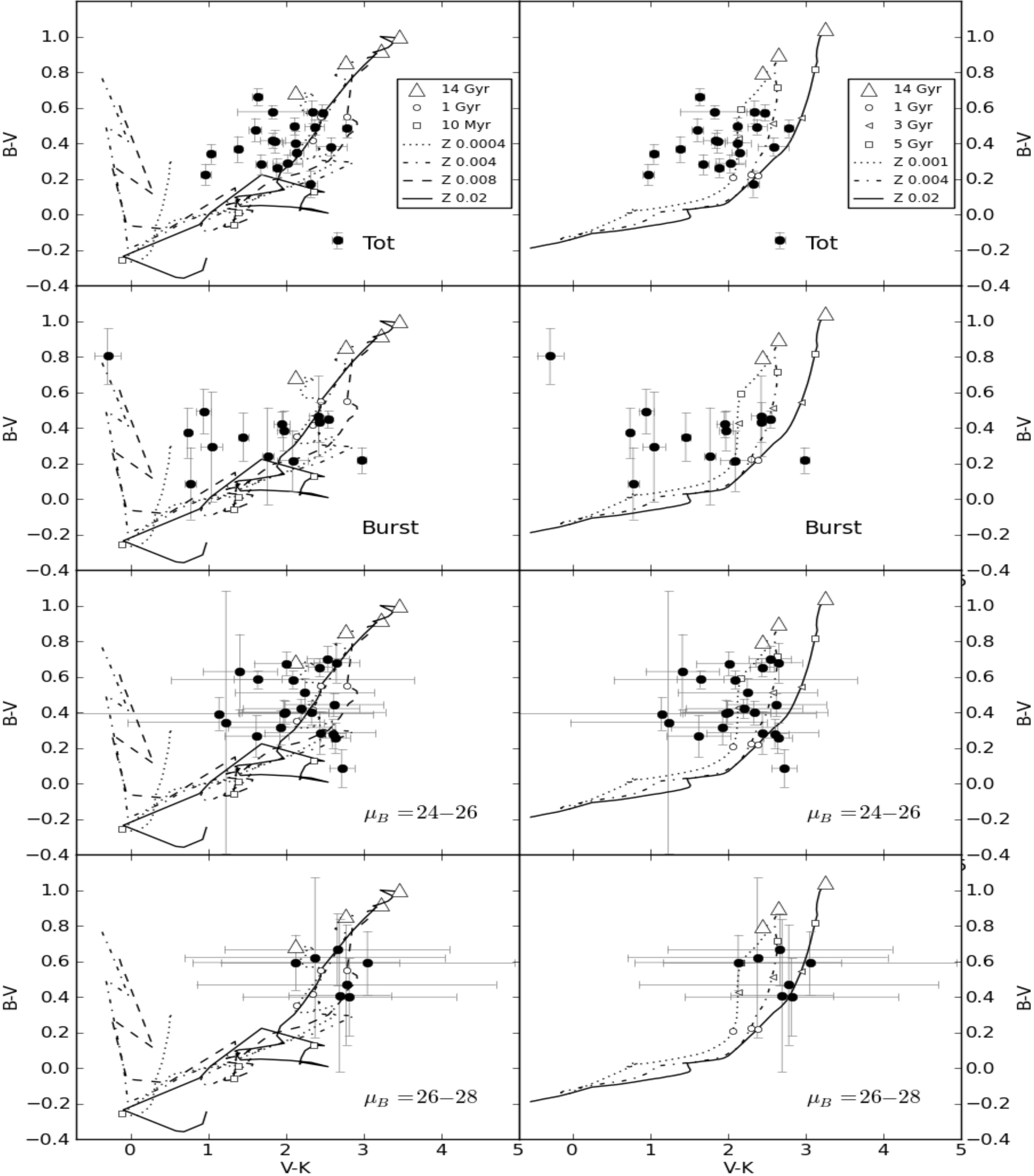


B-V=-0.88 ± 0.07 x S' + 0.85 ± 0.02 (Conselice 2003)

- Normal galaxies (Conselice 2003)
- BCGs (S1+S2)


ESO185-13 25.8/27.8
ESO338-04 25.7/27.7
ESO400-43AB 25.9/27.9
ESO421-02 25.9/27.9
HE2-10 25.5/27.2
HL293B 25.7/27.7
IIZw40 23.5/26.0
MK600 25.8/27.8
MK900 25.8/27.8

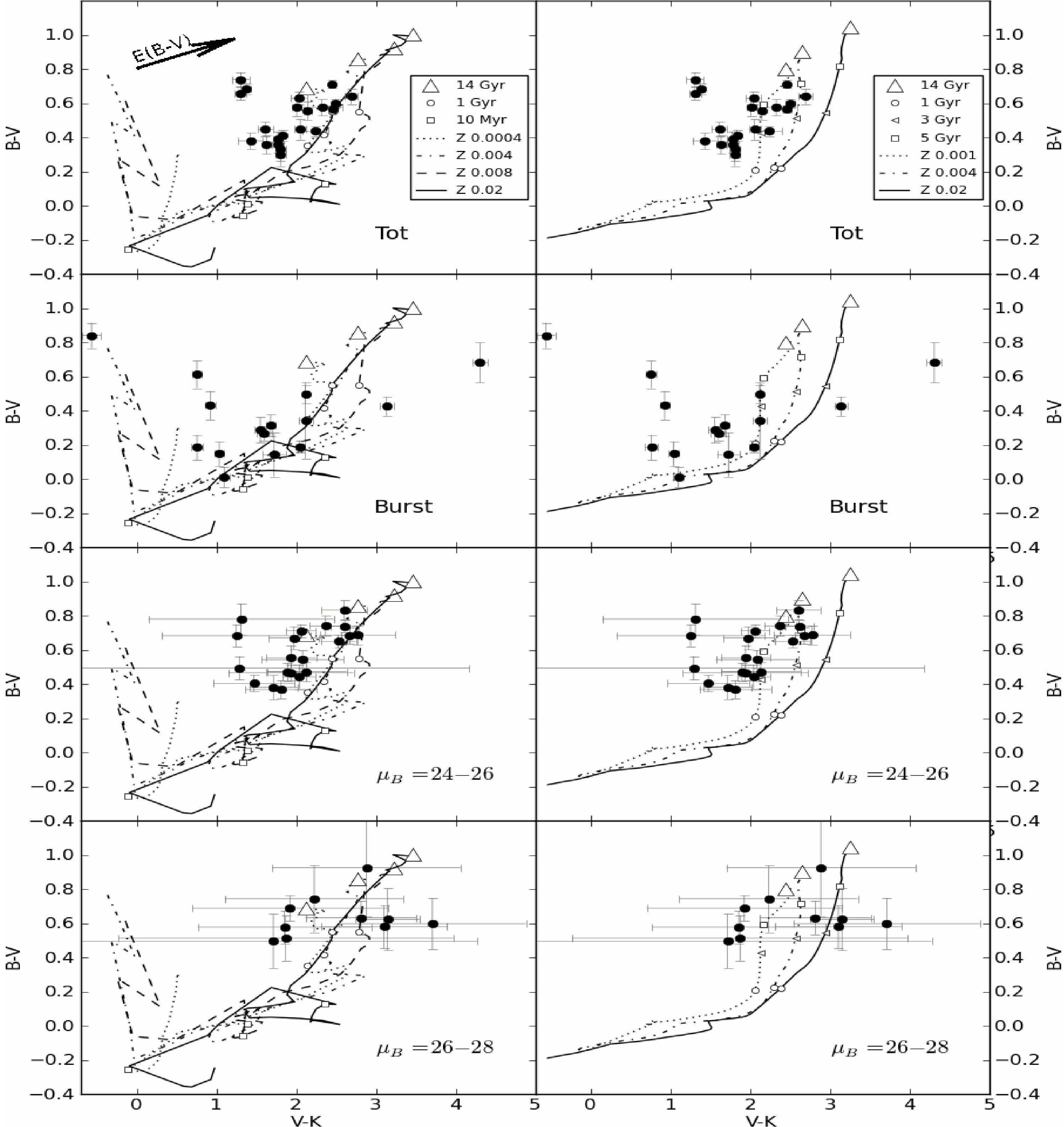

MK930 25.5/27.5
MK996 25.8/27.8
SBS0335-052EW 25.8/27.8
Tol0341-407 26.0/28.0
UM133 27.9/29.1
UM160 26.0/28.0
UM238 26.0/28.0
UM417 26.0/28.0
UM619 26.0/28.0



Sample 1

Left: Yggdrasil spectral synthesis code (Zackrisson et al. 2011), with *Starburst99* Padova-AGB stellar population, z=0, instant burst, nebular emission with *Cloudy* (Ferland et al. 1998), spherical geometry, $Z_{gas}=Z_{stars}$, covering factor = 1 (no LyC leakage), standard Johnson/Cousins filters

Right: Pure stellar population, Marigo et al. 2008 tracks, Salpeter IMF, exponentially decaying SF rate of 1Gyr, z=0, standard Johnson/Cousins filters



E(B-V)
14 Gyr
1 Gyr
10 Myr
Z 0.0004
Z 0.004
Z 0.008
Z 0.02
14 Gyr
1 Gyr
3 Gyr
5 Gyr
Z 0.001
Z 0.004
Z 0.02
Tot
Tot
Burst
Burst
$\mu_B = 24-26$
$\mu_B = 24-26$
$\mu_B = 26-28$
$\mu_B = 26-28$
B-V
V-K

Sample 2