

# Dwarf galaxies in Hickson Compact Groups

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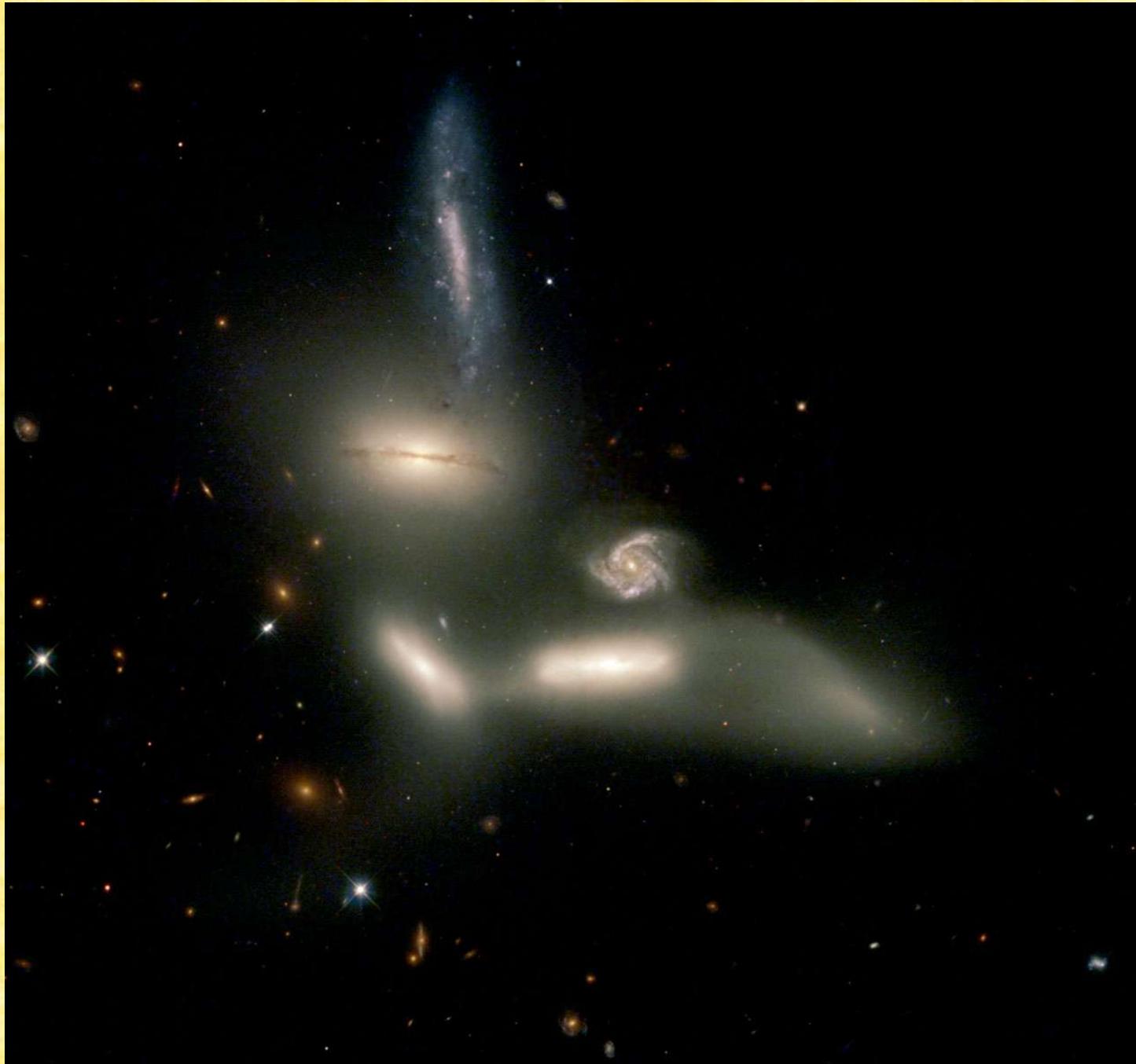
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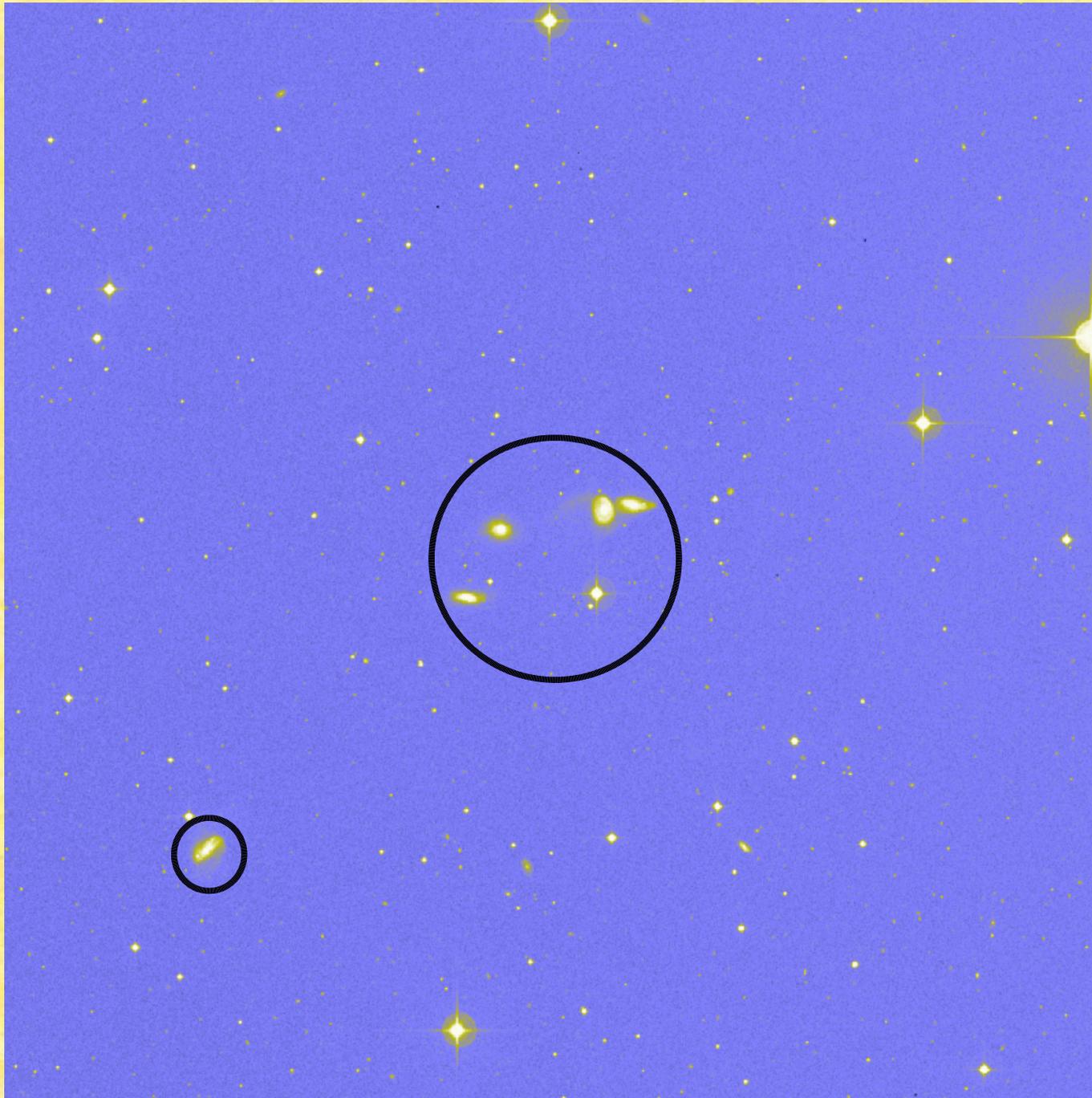
2) Astronomical Institute Potsdam

3) California State University, Sacramento

# Compact groups: e.g. Seyfert's Sextet



# Compact groups inside loose groups



HGC 16

spiral galaxy  
with same  
redshift

36'x36' FOV

# Galaxy Luminosity Function (LF)

$$\varphi(L) = \left( \frac{\varphi^{star}}{L^{star}} \right) \left( \frac{L}{L^{star}} \right)^\alpha e^{(-L/L^{star})}$$

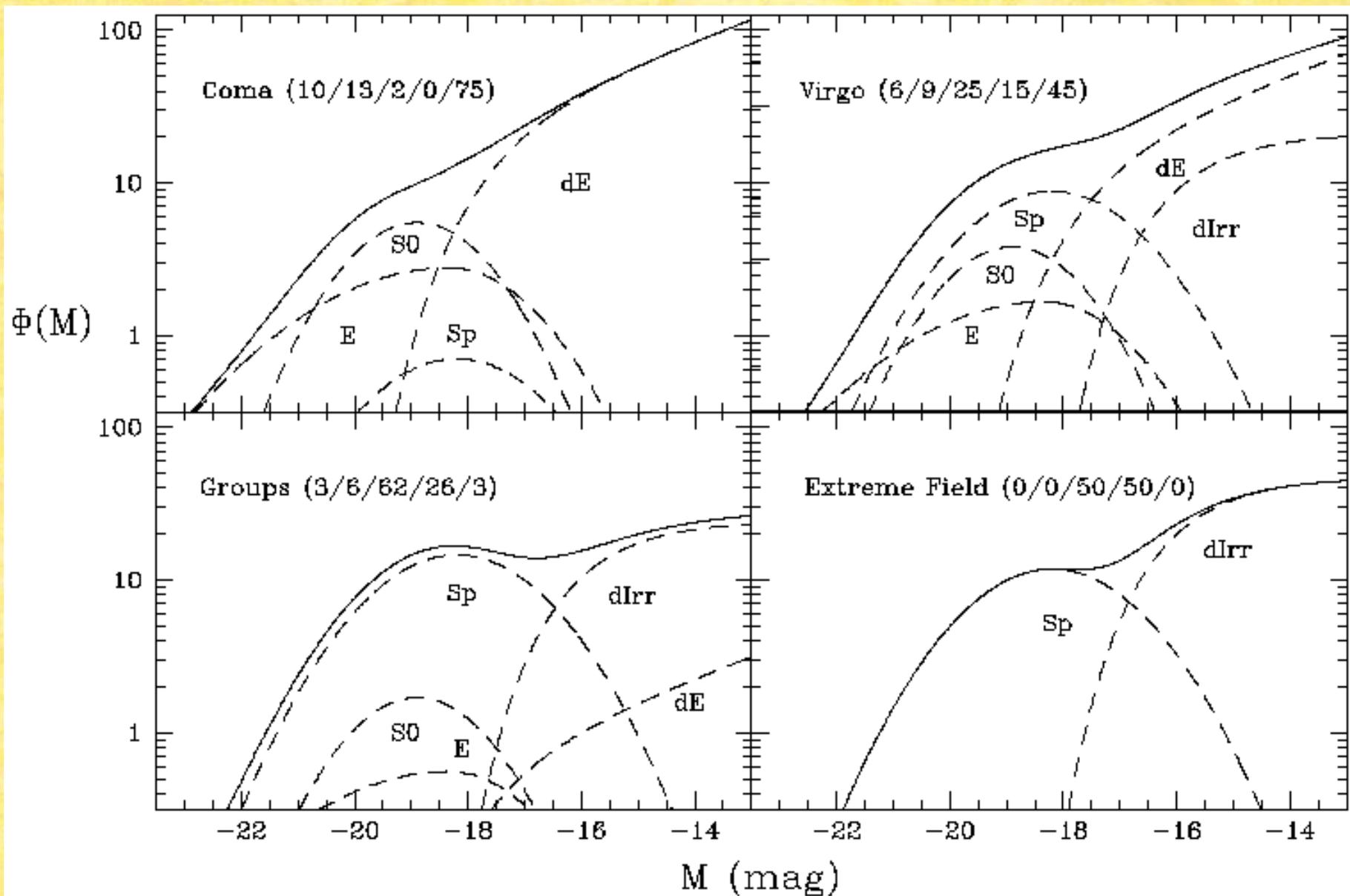
$$\varphi(M) = \frac{2}{5} \ln(10) \varphi^{star} \left( 10^{0.4(M^{star} - M)} \right)^{\alpha + 1} e^{-10^{0.4(M^{star} - M)}} \quad \text{Schechter '76}$$

$L^*$ ,  $M^*$ ,  $\alpha$ : fitting parameters  
 $\Phi^*$ : normalization parameter

$\alpha$  : determines the slope of the LF at the faint end  
 $\alpha < -1$  : divergent  
 $\alpha = -1$  : flat  
 $\alpha > -1$  : declining

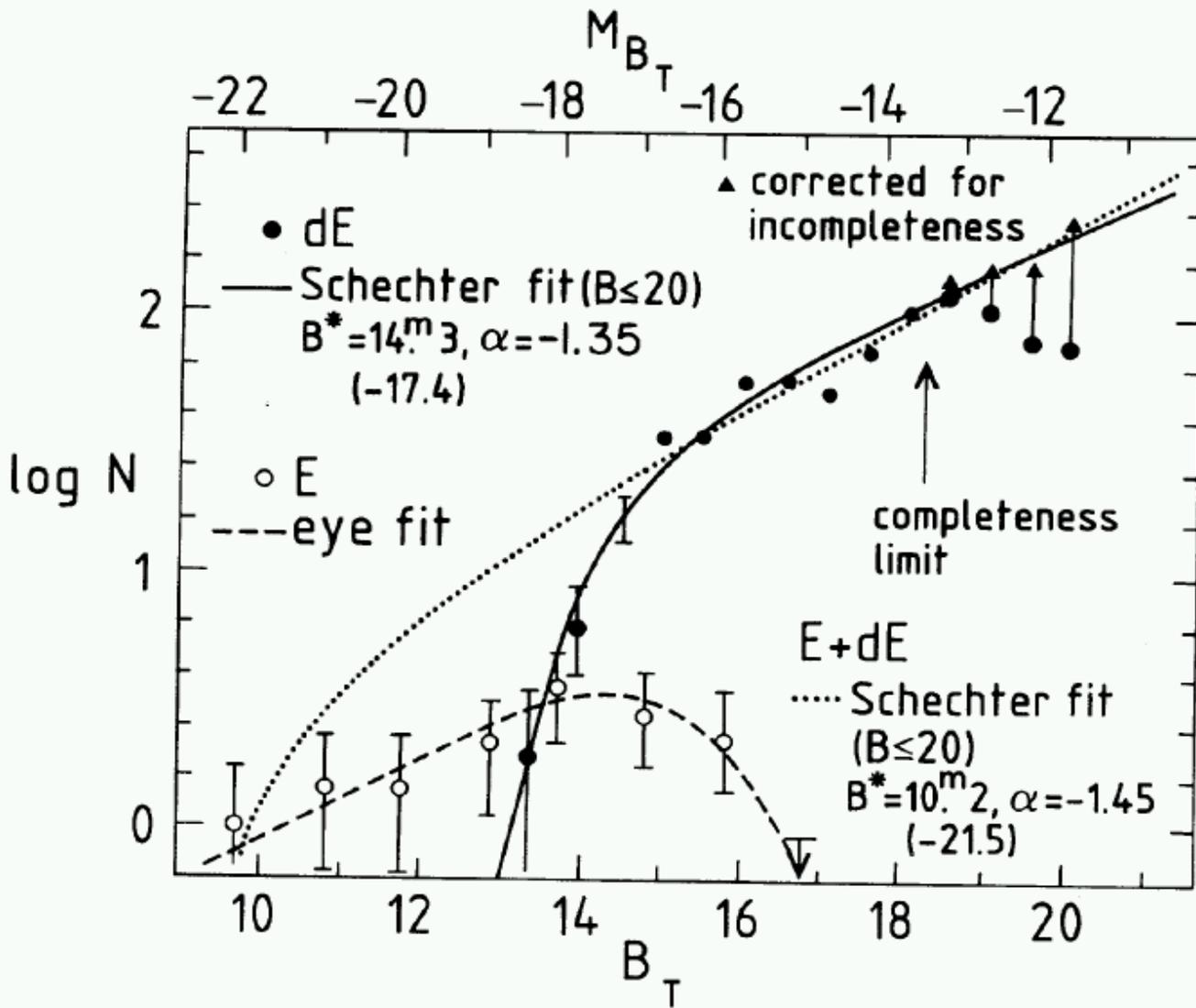
$L^*$ ,  $M^*$  : Luminosity, absolute Magnitude at which the LF shows a change in the slope

# Galaxy LFs in different environments



# LF of a Galaxy Cluster

(Virgo cluster; Sandage et al. 1985)

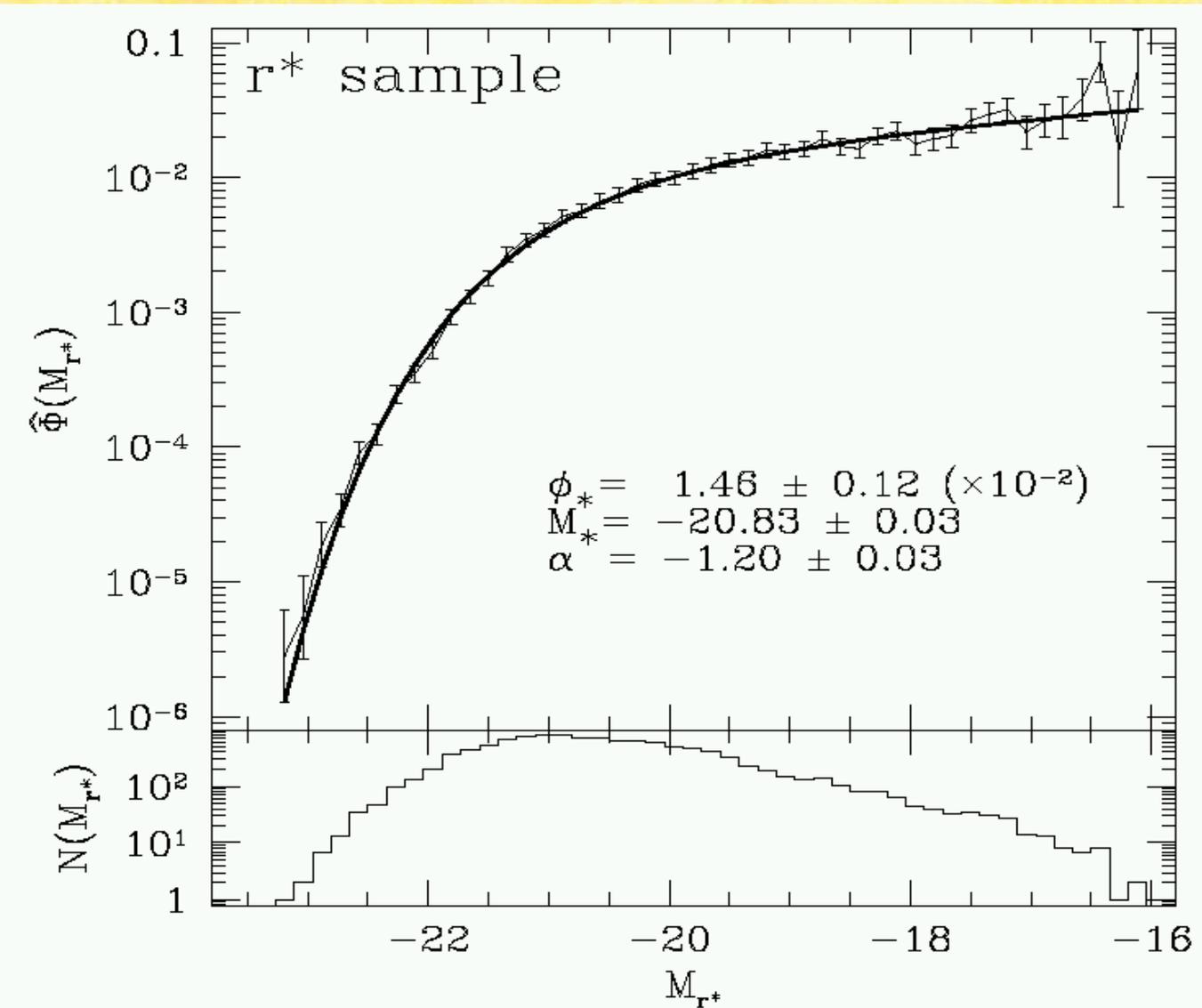


steep faint end due to dE/dSph

$M^* (E + dE) = -21.5 \text{ mag}$   
 $\alpha = -1.45$   
 E & dE LFs do not fit together,  
 => suggesting separate families

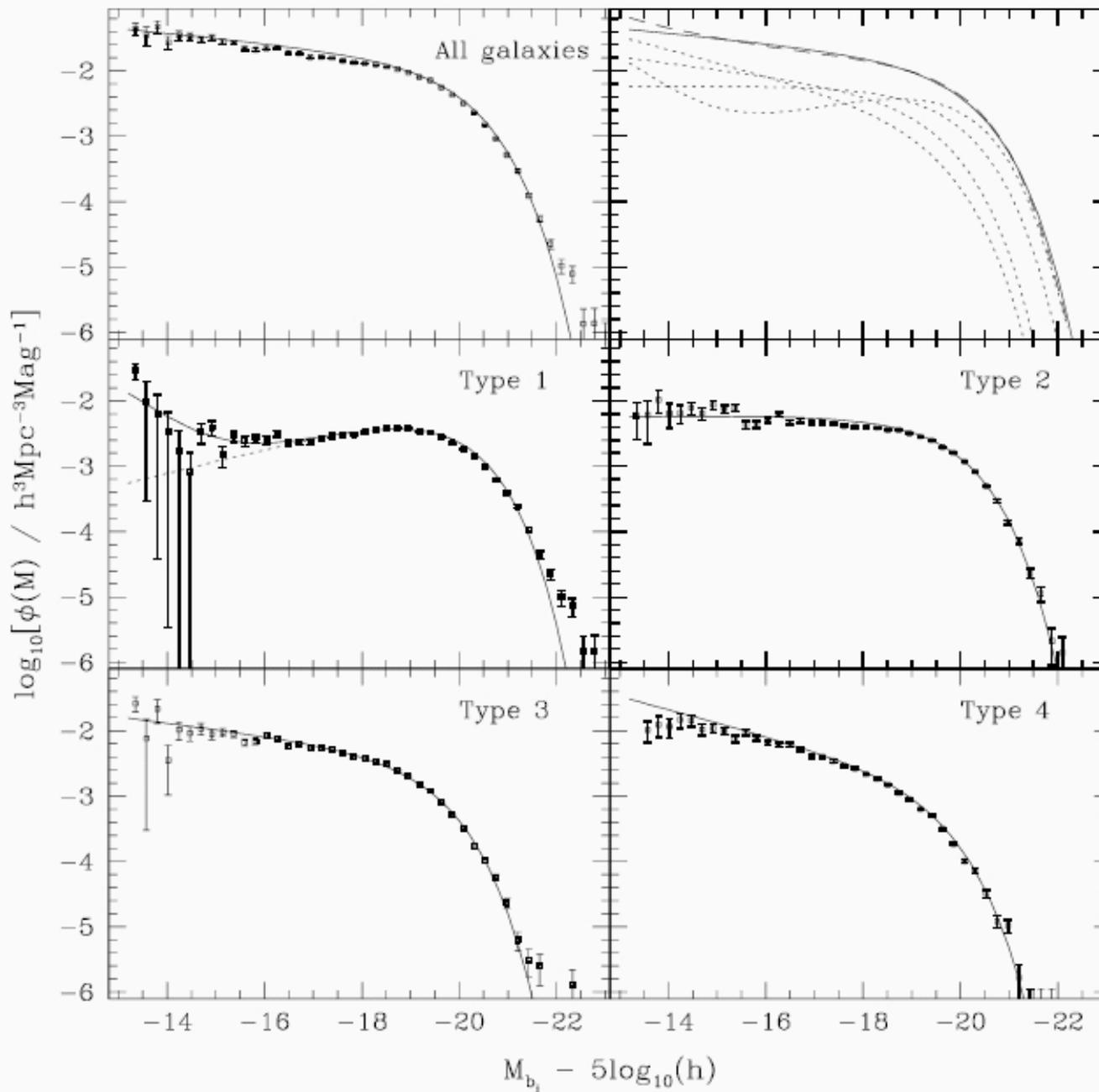
# LF of (mainly) field galaxies

(SDSS; Blanton et al. 2001)



$M^*$  (all types) =  $-20.83 \pm 0.03$  mag  
 $\alpha = -1.20 \pm 0.03$

# Luminosity Functions for galaxy types



2dFRS

type 1: passiv  
evolution  
type 4: strong  
star formation

# LF of Compact Groups ?

- former studies: LFs similar to the field  
(e.g. Ribeiro et al. 1994, Kodaira et al. 1991)

but:

- small area
  - relatively bright limiting magnitude
  - limited information concerning group membership
- 
- recent studies: dwarf galaxies!  
(e.g. Miles et al. 2004, Zabludoff & Mulchaey 2000)

=> very deep, wide-field sample of HCGs

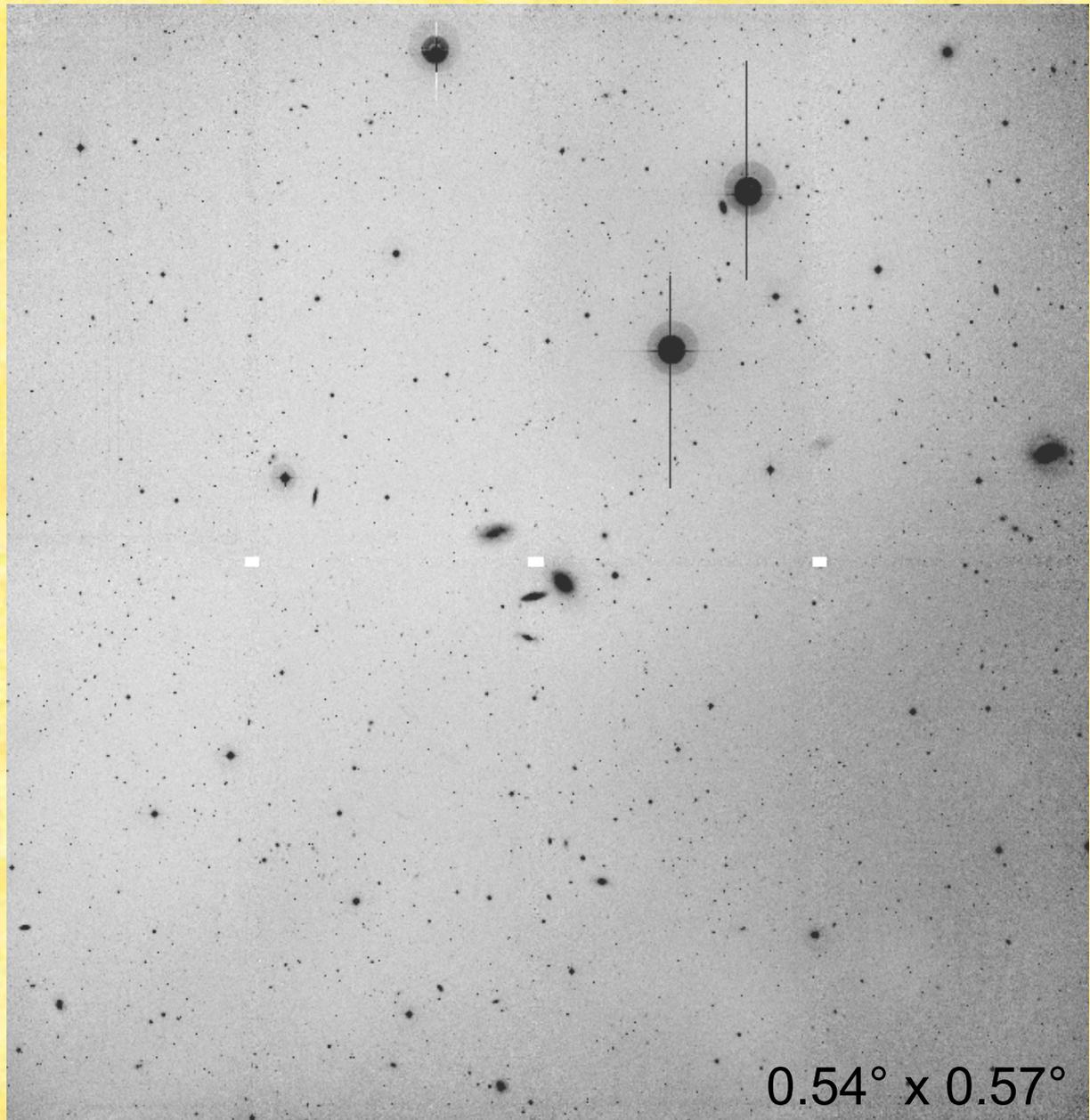
# Data & Data reduction

Sample

HCG 16, 19, 30, 31, 42  
(distance < 50Mpc)

ESO/MPI 2.2m telescope  
+ WFI

- 8 CCD-detector mosaic  
(2k x 4k each)
- field size:  $0.54^\circ \times 0.57^\circ$
- sampling:  $0.24''/\text{pixel}$
- seeing:  $0.8'' \dots 1.0''$



Mosaic image of HCG 19 in the R-band

# Data & Data reduction

## Observational parameters

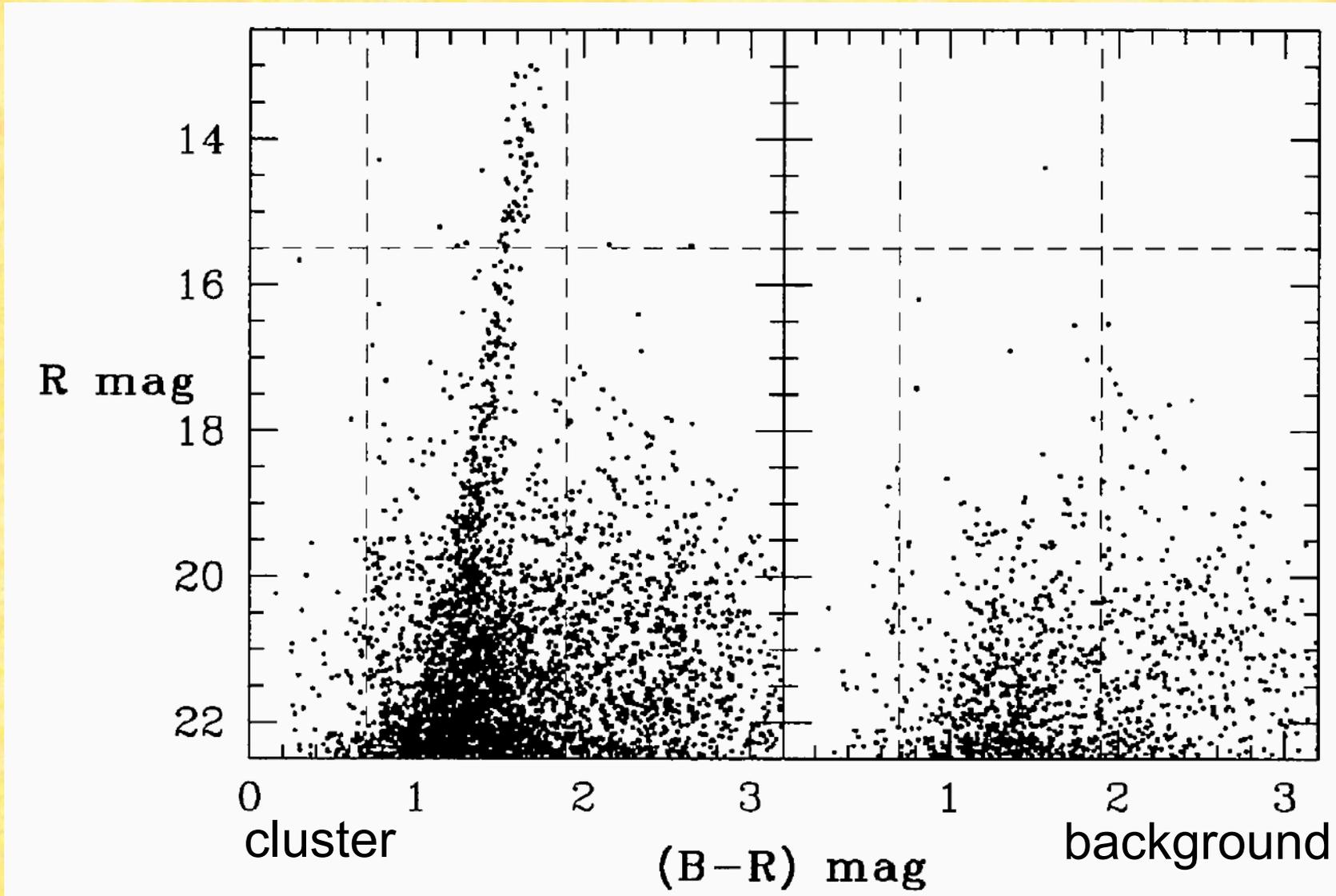
- filter bands: B & R
- integration time : 5400s in B, 2700s in R
- surface brightness limit: 27 mag/arcsec<sup>2</sup> in B,  
26 mag/arcsec<sup>2</sup> in R

## Data reduction

- IRAF mscred package (Valdes '98)  
+ own reduction scripts
- Object detection & extraction (SExtractor: Bertin '96)  
=> **2700 - 5000 galaxies per field**
- first selection criterium:  
Physical size > 570pc = smallest local group galaxy (Mateo '98)  
=> **212 - 470 dwarf galaxy candidates per field**
- additional selection criteria to suppress higher redshift contamination  
similar to Conselice et al. (2002)

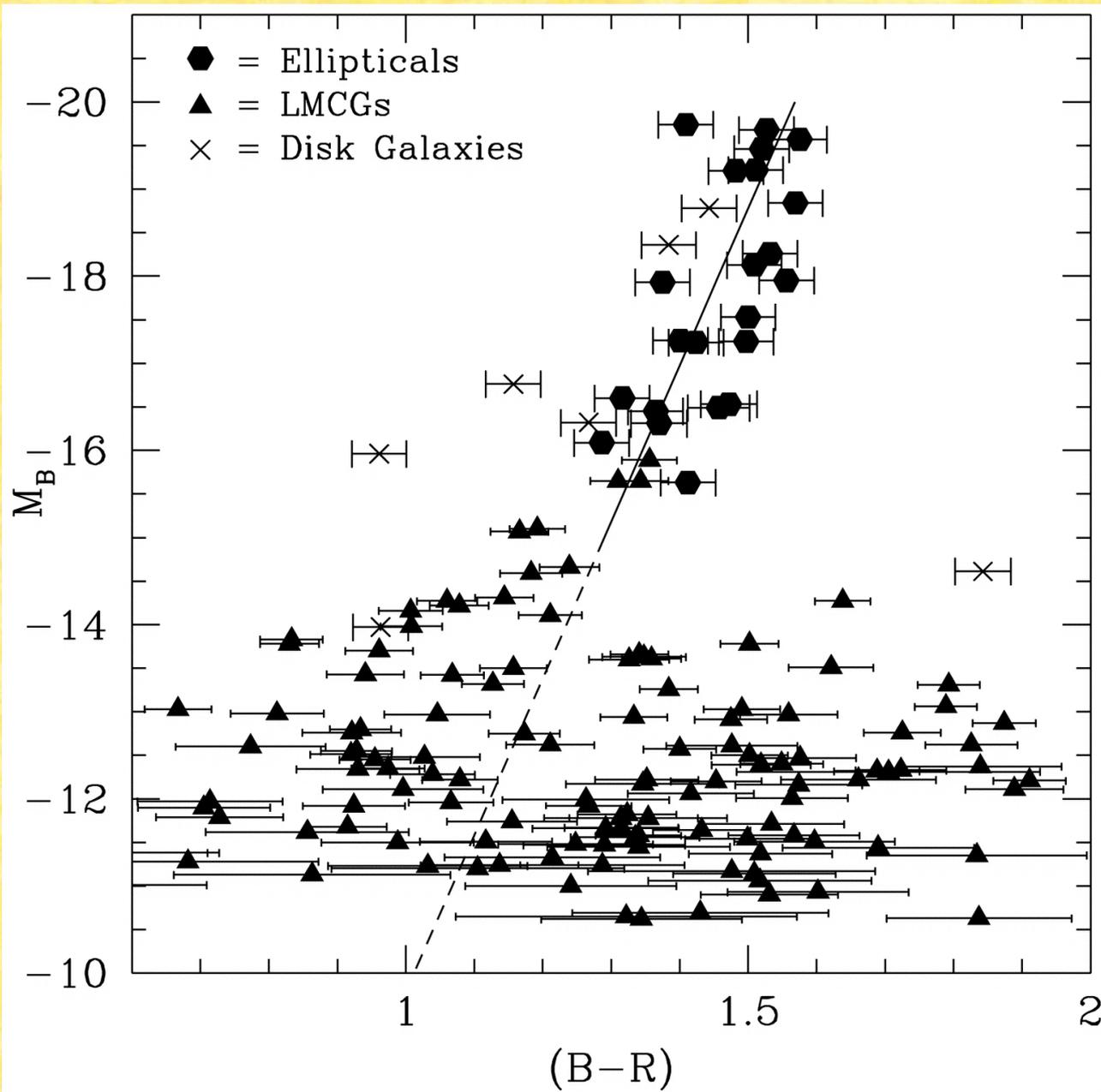
# The red sequence at low luminosity

Color-Magnitude Diagram (CMD) for the Coma Cluster core



# The red sequence at low luminosity

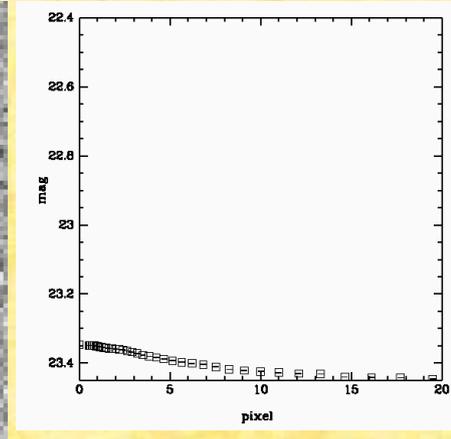
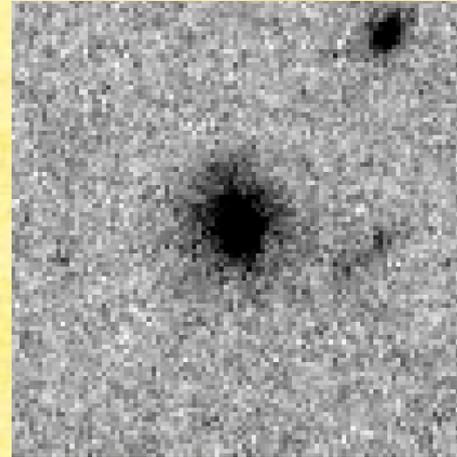
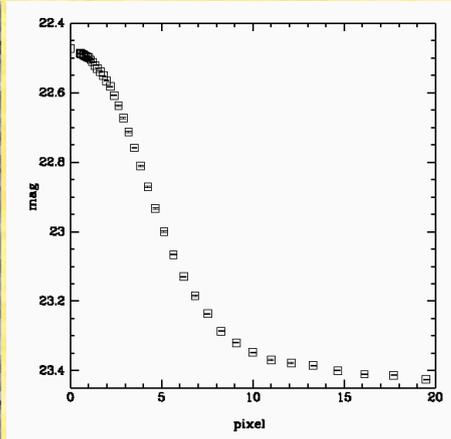
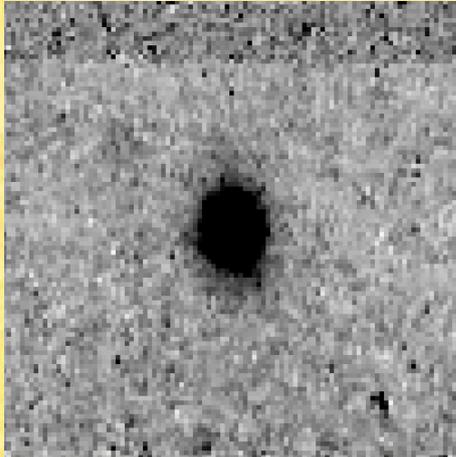
Color-Magnitude Diagram (CMD) for the Perseus Cluster core



Large color spread  
at low luminosity

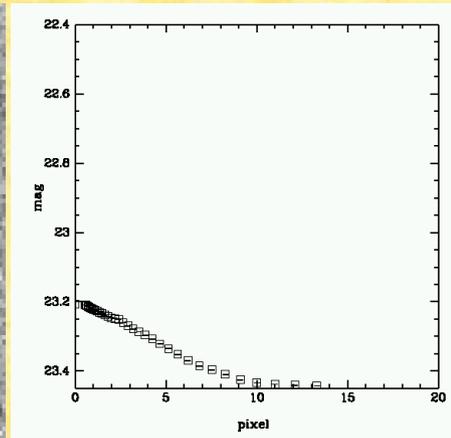
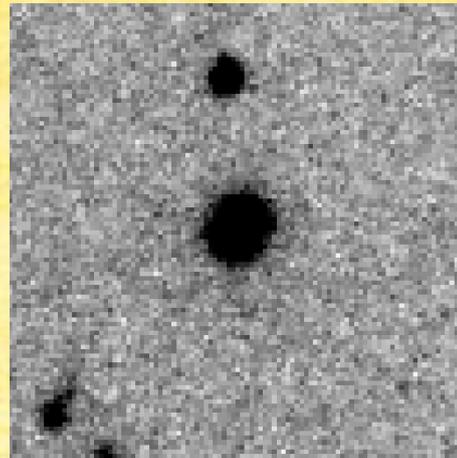
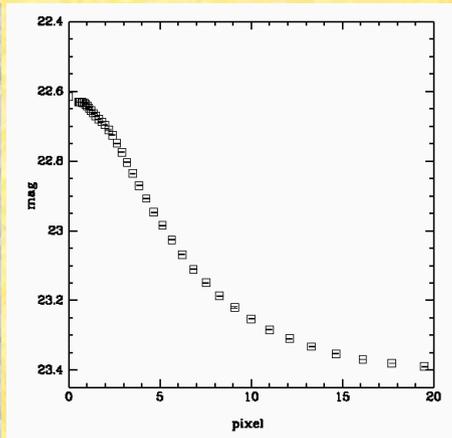
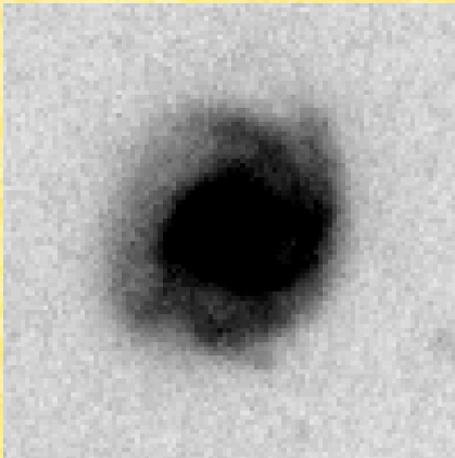
# Additional selection criteria

central surface brightness, morphology, exponential light profile



background elliptical

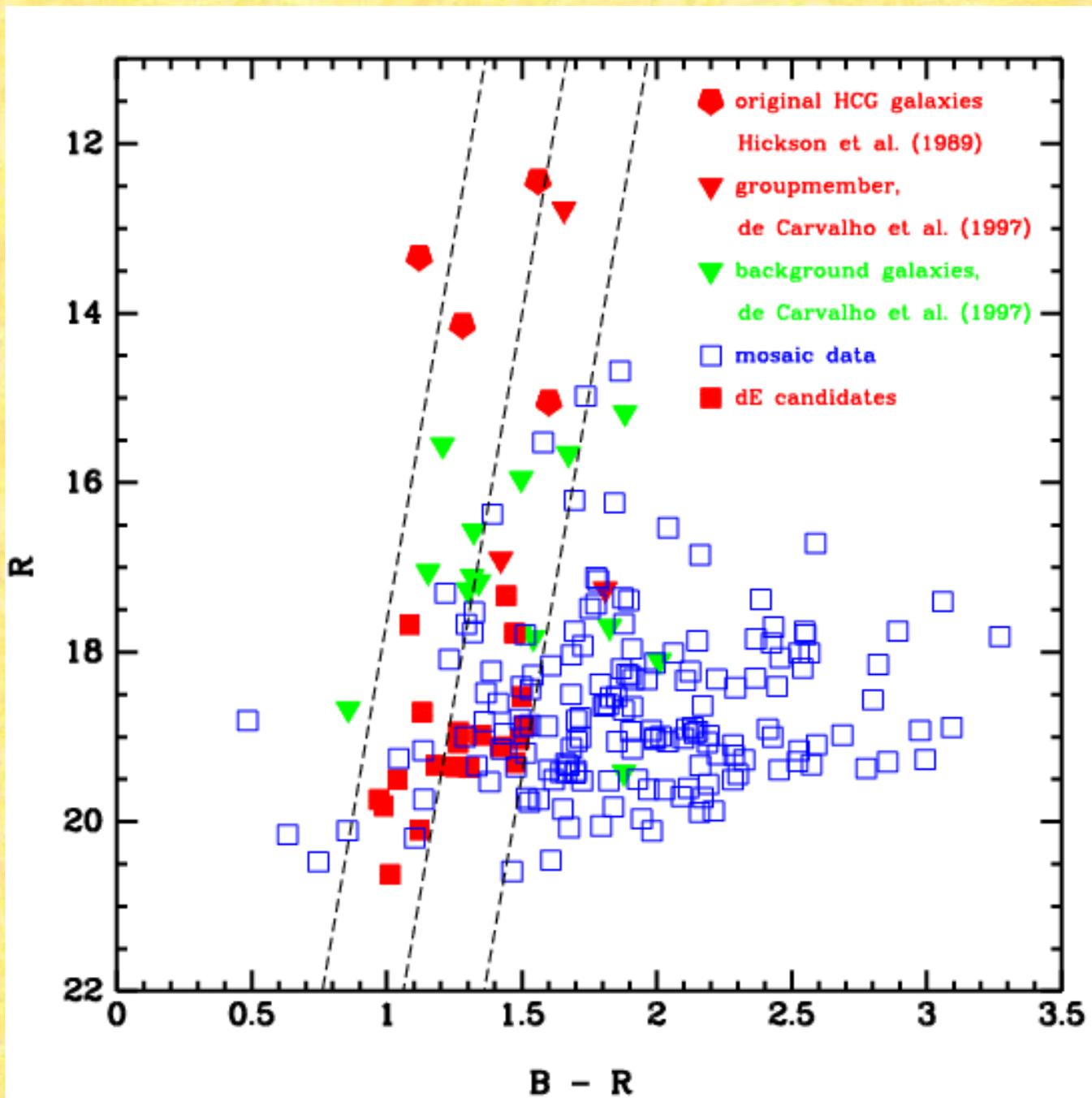
high probability dE member



background spiral

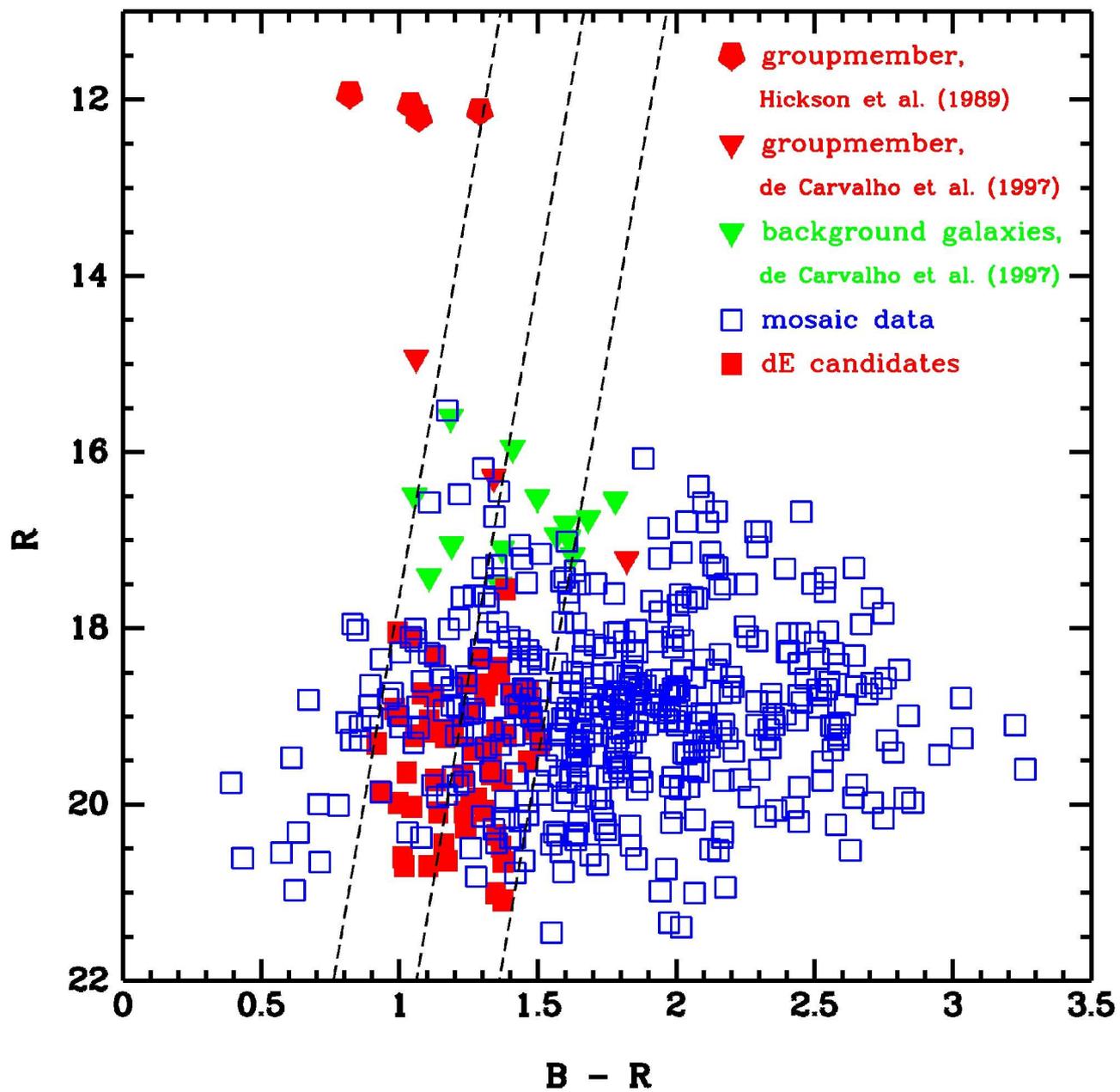
high probability dE member

# CMD for galaxies in HCG 19

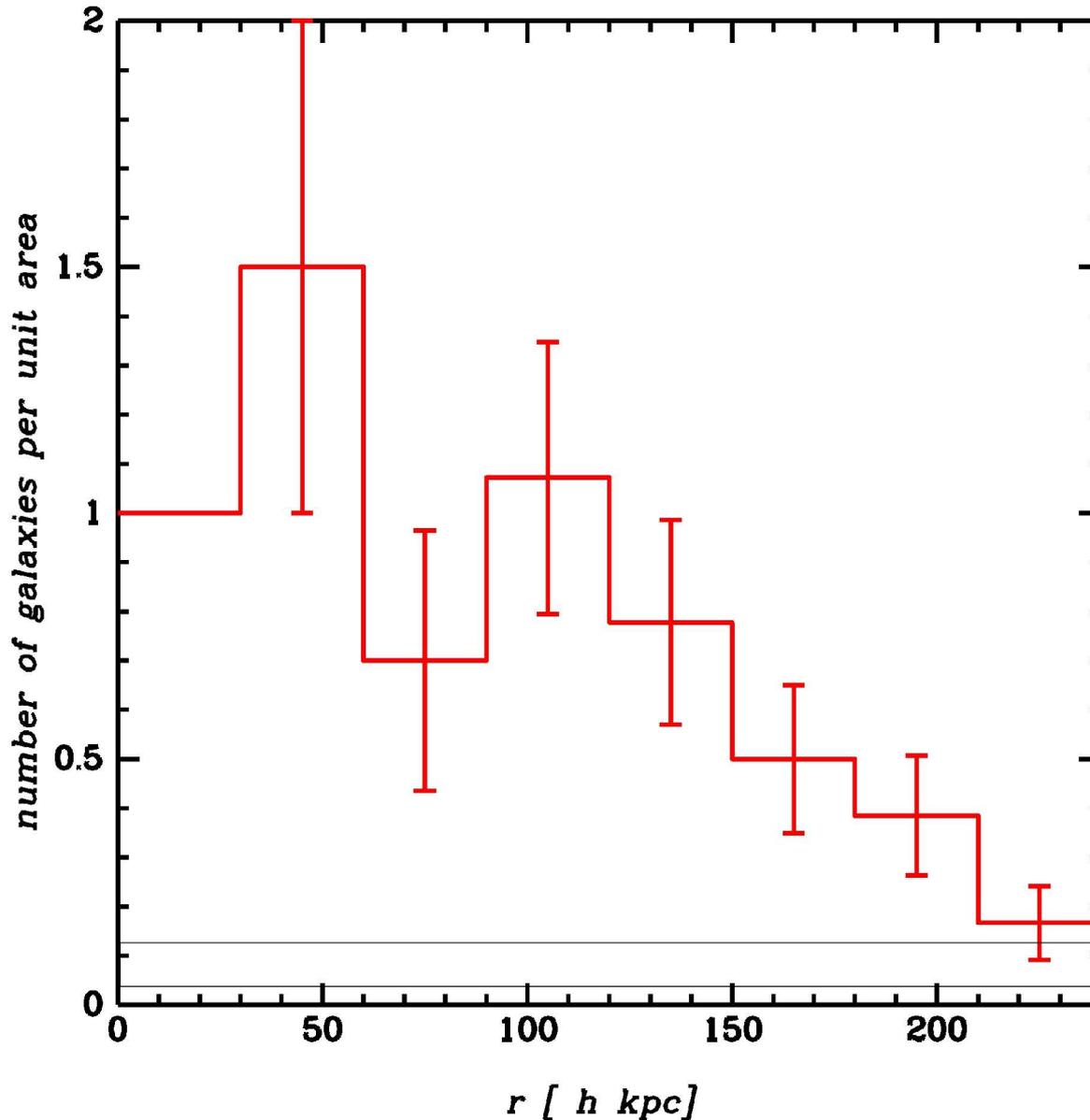


Krusch, Bomans,  
et al. 2005b,  
submitted

# CMD for galaxies in HCG 16

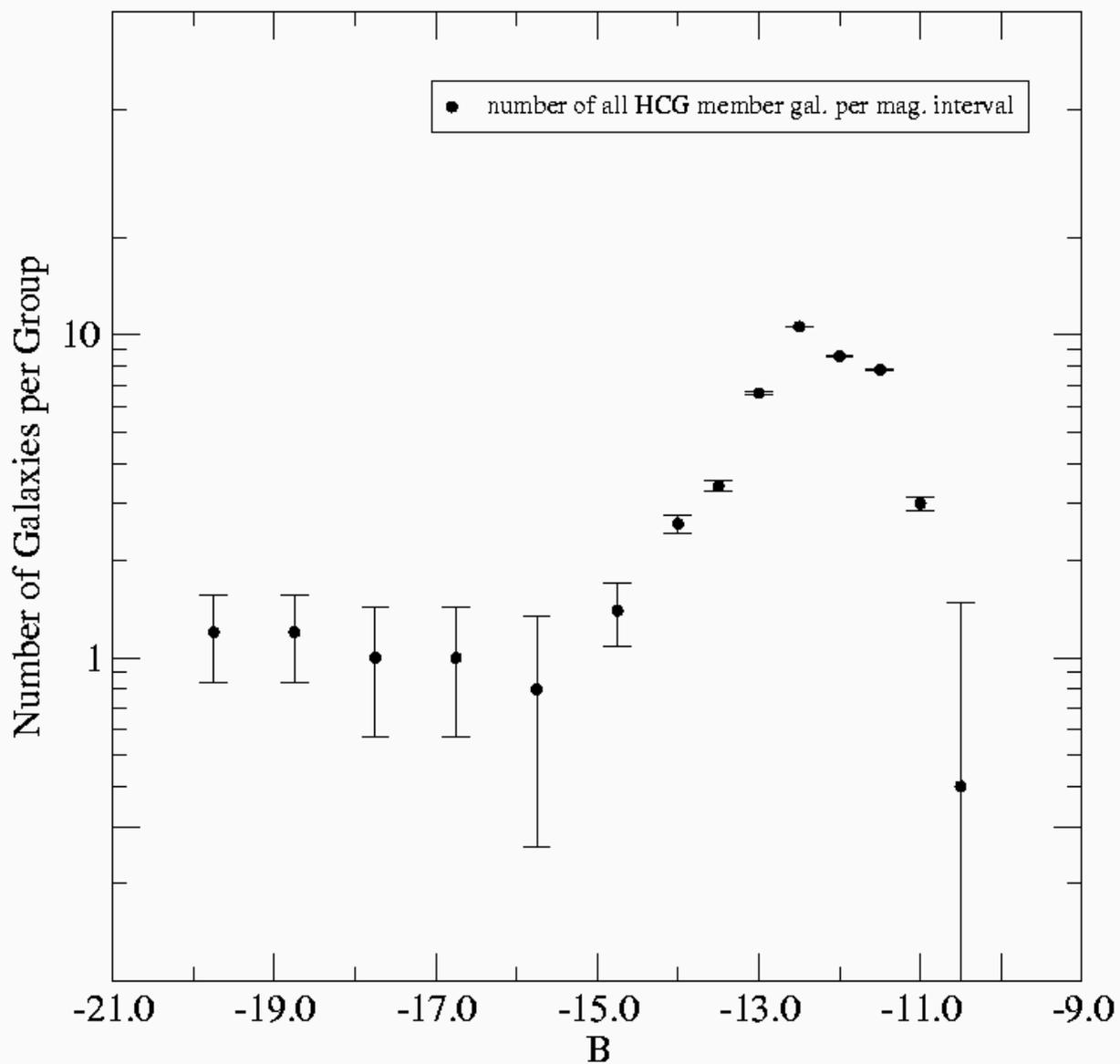


# Surface density distribution of HGC 16



- dwarfs concentrated towards HCG
- WFI images often do not reach group limit

# Total LF of the 5 HGCs



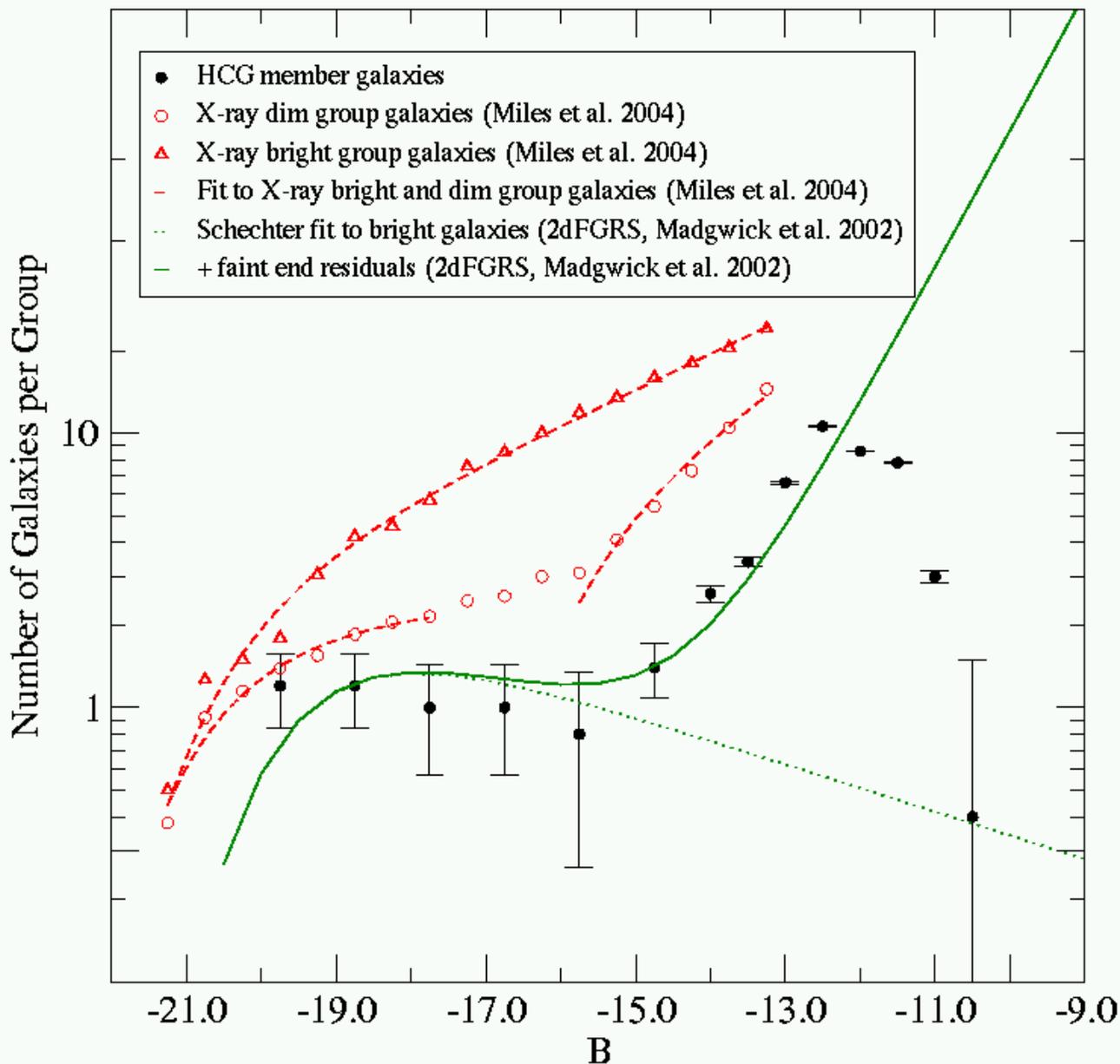
Bimodal structure  
of LF

Krusch, Bomans,  
et al. 2005a, submitted

completeness limit:  
 $M_B \sim -12$  mag

(-20.25 mag < B < -16.25 mag) binned in 1 mag steps  
(-16.25 mag < B < -10.25 mag) binned in 0.5 mag steps

# LF of HCGs

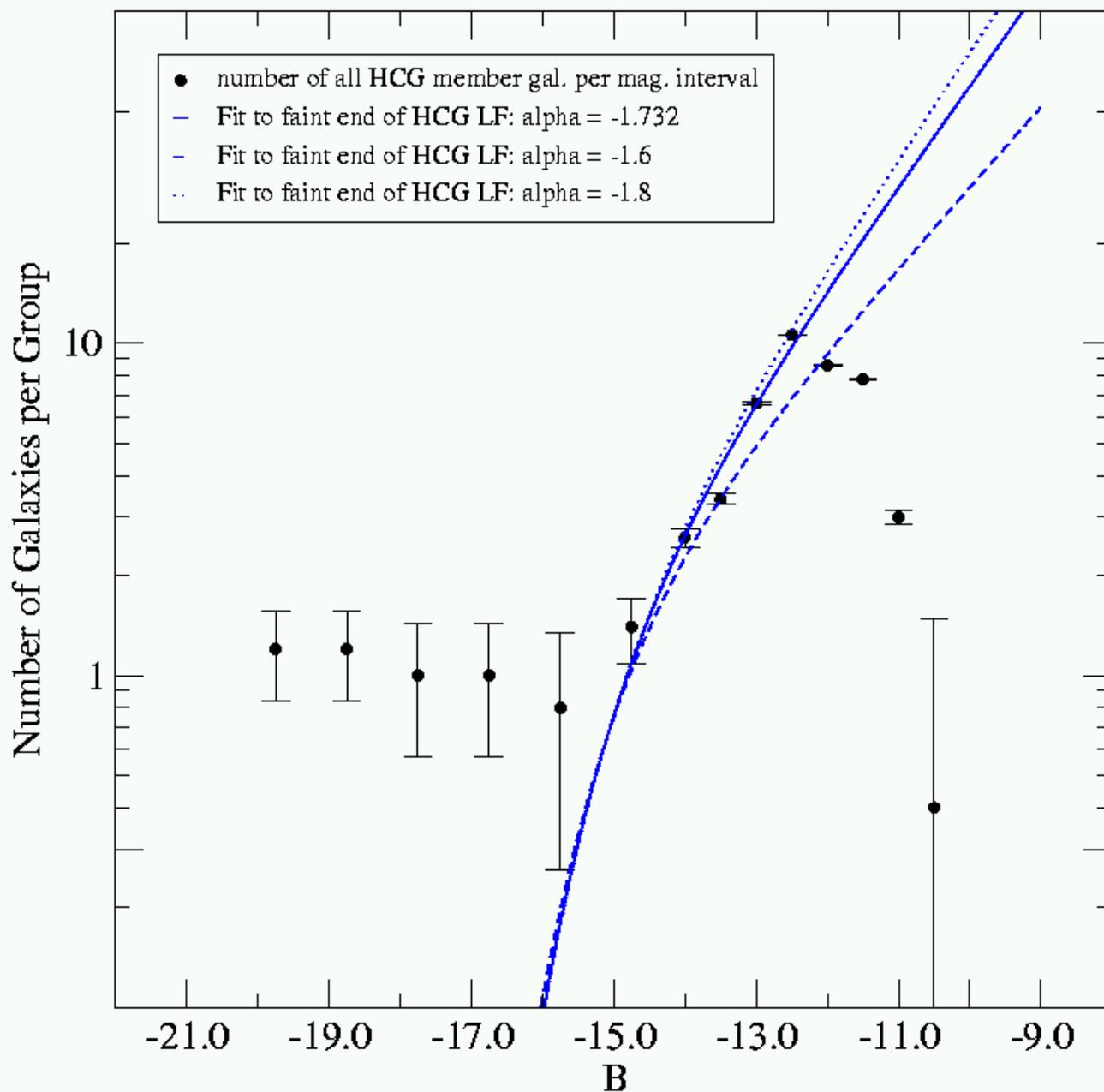


bimodal structure  
also in LF of  
X-ray dim groups  
(Miles et al. 2004)

and Leo group  
(Flint et al. 2001)

and similar to break  
in LF of passively  
evolving field  
galaxies  
(Madgwick et al. (2002))

# LF of HCGs vs. CDM theory



Very steep faint end slope in Compact group

Predictions of CDM - theory:  
 $\alpha > -1.7$   
(Klypin et al. 1999)

# Summary

- large dwarf galaxy population in the 5 compact groups
  - most dwarfs of dE/dSph type
  - distributed in a “halo” around HGC core
  - resulting luminosity function down to  $M_B = -12$  mag
  - bimodal LF in clusters and passively evolving galaxies
  - HGCs may be building blocks of clusters
  - observed  $\alpha \sim -1.7$  similar to CMD predictions
- > the missing satellites ?  
**but: not spectroscopy of the dwarfs yet**

# Outlook

**spectroscopy of all high probability member galaxies  
with VLT/VIMOS**

**data for HGC 16 and 31 just taken**

- **verify group membership => test preselection criteria  
=> verify LF of HCGs**
- **dynamical analysis of the dwarf component**
- **internal properties of the dwarfs**

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