

Stellar Populations in BCDs

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Stellar populations in BCDs

1970

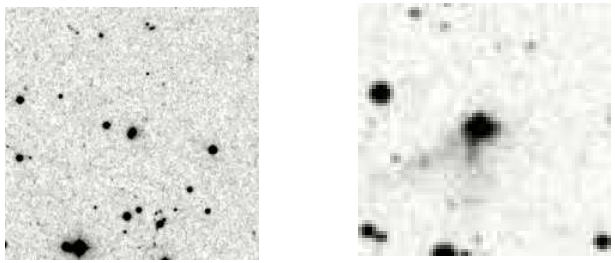
ISOLATED EXTRAGALACTIC H II REGIONS*

WALLACE L. W. SARGENT† AND LEONARD SEARLE
Hale Observatories, California Institute of Technology,
Carnegie Institution of Washington

Received 1970 November 2

ABSTRACT

Two isolated dwarf emission-line galaxies are shown to be observationally indistinguishable from giant H II regions in nearby galaxies. Either they are young systems or, more likely, the luminosity function of newly formed stars in them differs radically from that found in the Galaxy.



1978−1980 **O'Connell, Thuan & Goldstein**
Balkowski et al., Lequeux & Viallefond

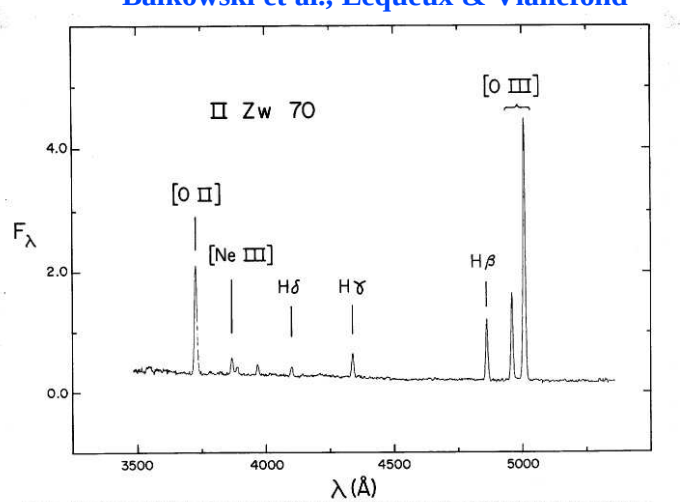


FIG. 1a.—Blue IDS scans (11 Å effective resolution) of II Zw 70 reduced to the rest frame. The ordinate is $F_\lambda \times 10^{14}$, where $[F_\lambda]$ = ergs s^{-1} cm^{-2} Å^{-1}. No reddening corrections have been applied. Note the absence of structure in the continuum, especially the lack of absorption features or a Balmer discontinuity.

1980−1981 **Terlevich & Melnick**
Thuan & Martin

Defining Criteria for BCDs

Compact optical appearance, fainter than −18 B mag,
no spiral arms, narrow Balmer emission lines ontop
a blue stellar contiuum
gas−rich, metal−poor

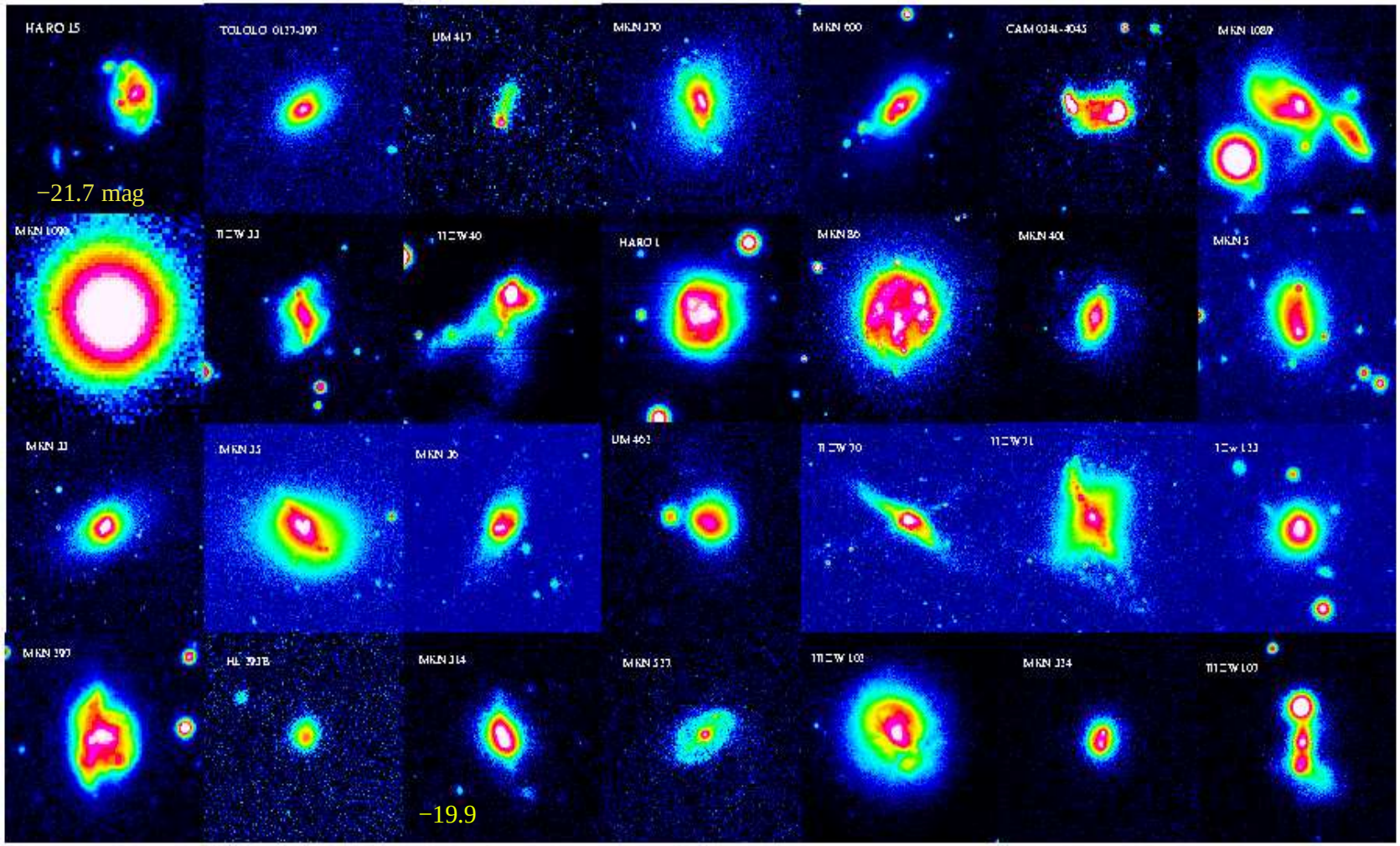
1983−1988 **Loose, Thuan, Fricke**
Thuan
Kunth et al.

LSB
host galaxy

new BCDs in several surveys (SBS, UM, KISS, SLOAN, 2dF ..)

HII, **E**mission **L**ine, **W**olf−**R**ayet galaxies
Blue Amorphous galaxies
Luminous **B**lue **C**ompact galaxies
Dwarf **I**rregular
Star **F**orming **D**warf galaxies

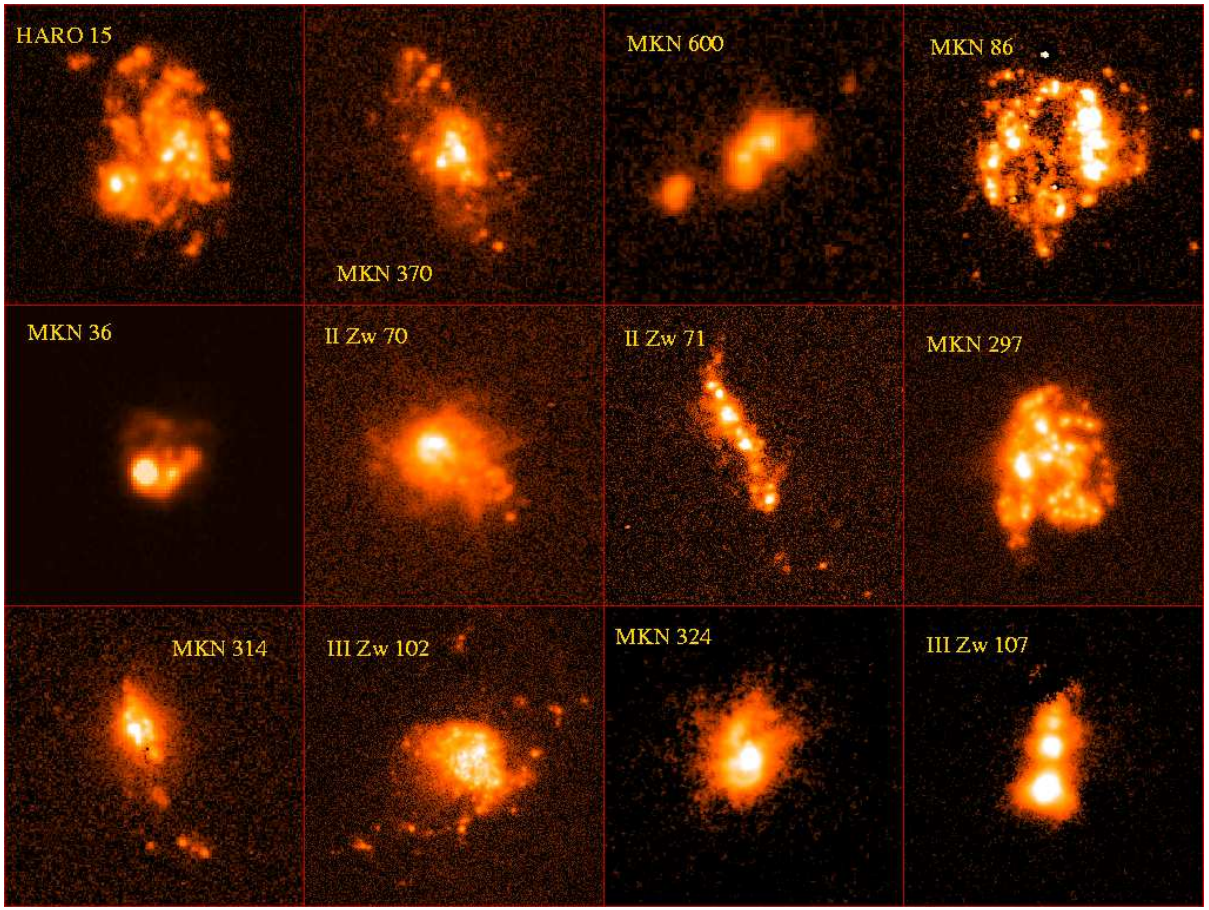
Stellar populations in BCDs



Cairós (2000)

A morphologically heterogeneous class

the high−surface−brightness component of BCDs shows a wide morphological variety ...

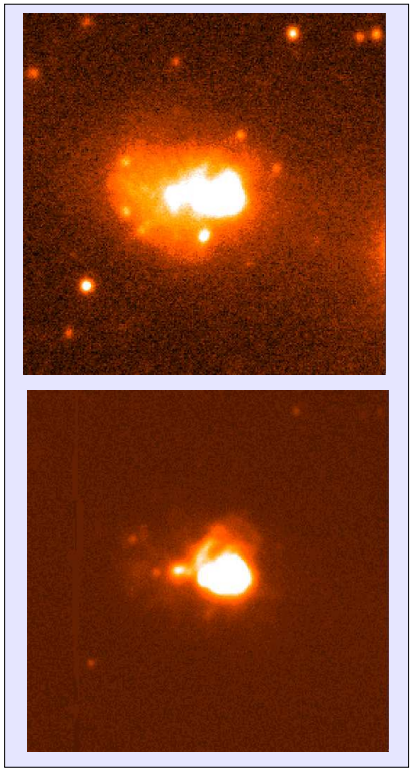


Cairos et al. (2001b)

http://www.iac.es/proyect/GEFE

Other Hα Atlasses for BCDs in, e.g.

Marlowe et al. (1995)



Gil de Paz et al. 2003

Stellar populations in BCDs: empirical classification

Loose & Thuan (1986a)

nE
nuclear elliptical

iE
irregular elliptical

iI; iI,C
irregular−irregular
cometary iI

i0
irregular−0

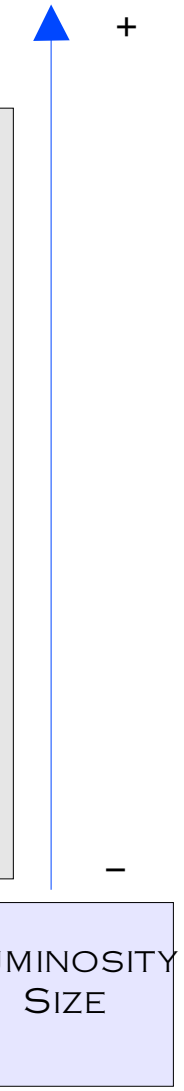
Salzer et al. (1989)

SBN
Starburst nucleus

DANS
dwarf amorphous nuclear starburst

DHIIH
Dwarf HII hotspot

SS
Sargent & Searle

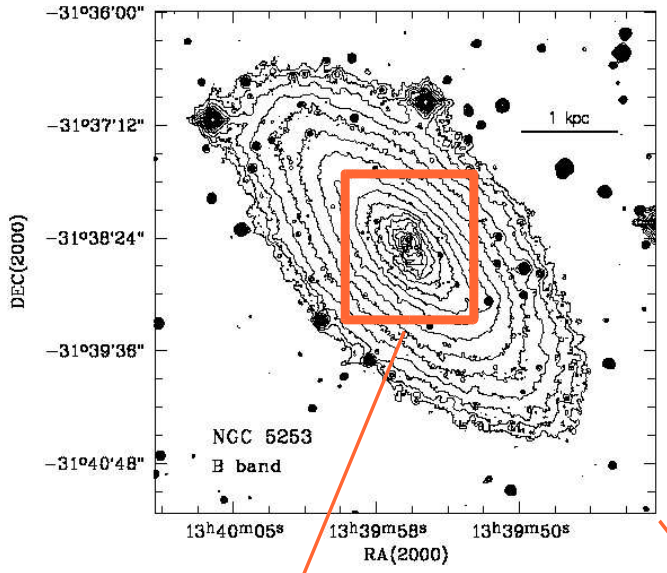


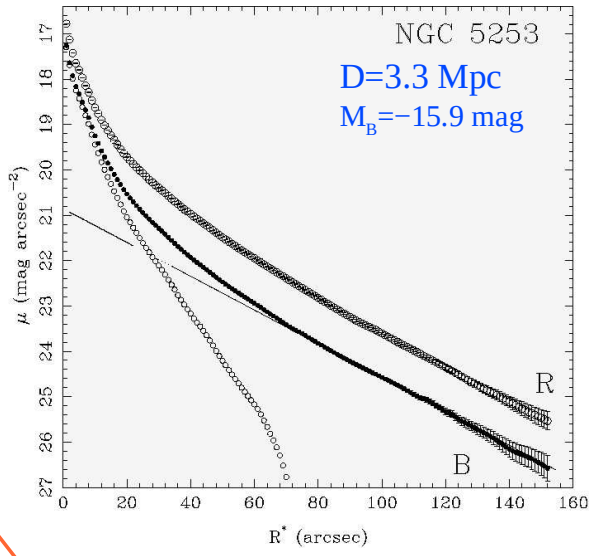
Telles et al. (1997)
SF−component: *multiplicity*

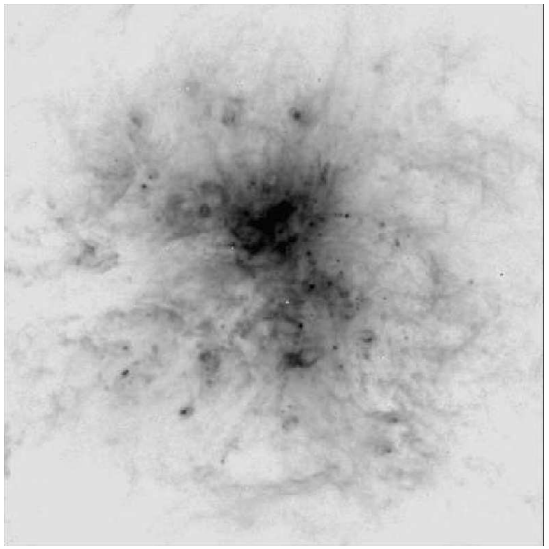
Cairos et al. (2001b):
SF−component: *nuclear, extended, chain,cometary*

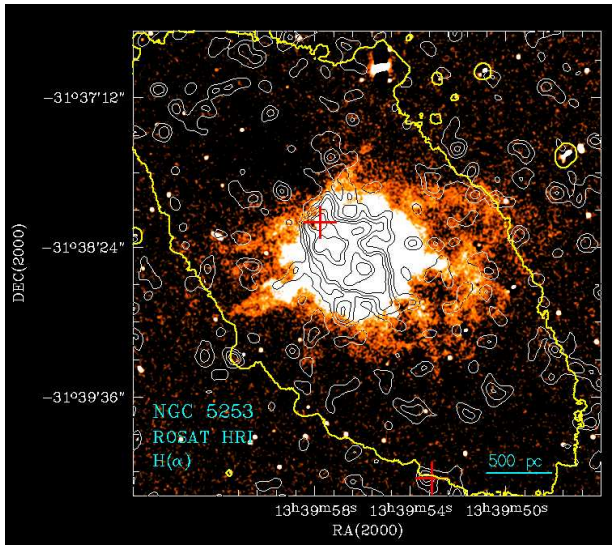
Standard and distance−independent representation of the photometric structure of BCDs
surface photometry/decomposition of surface brightness profiles

Stellar populations in BCDs: nuclear elliptical **nE** (20%)



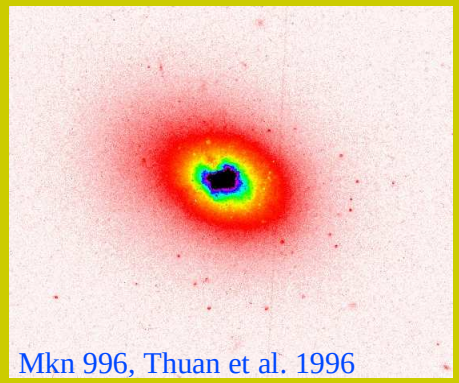




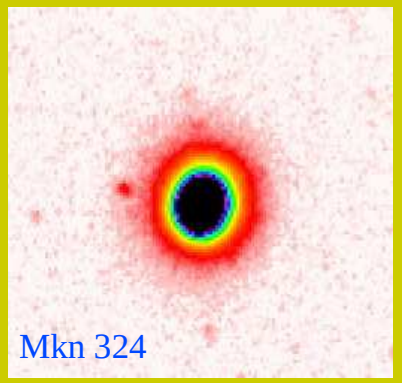


HST WFPC2, Calzetti et al. (1997)

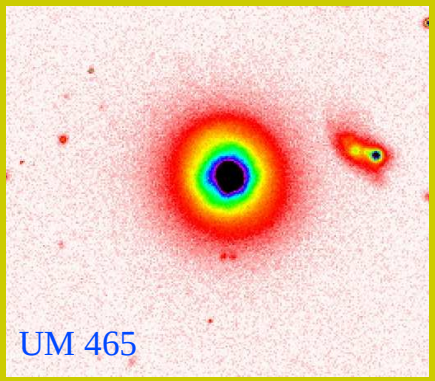
other examples ....



Mkn 996, Thuan et al. 1996



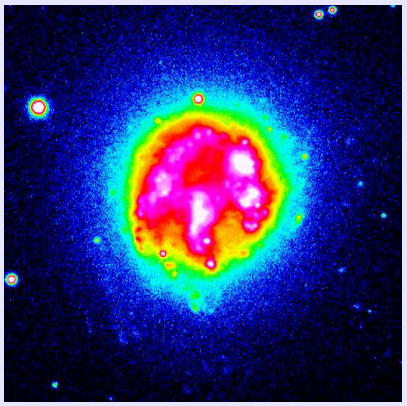
Mkn 324



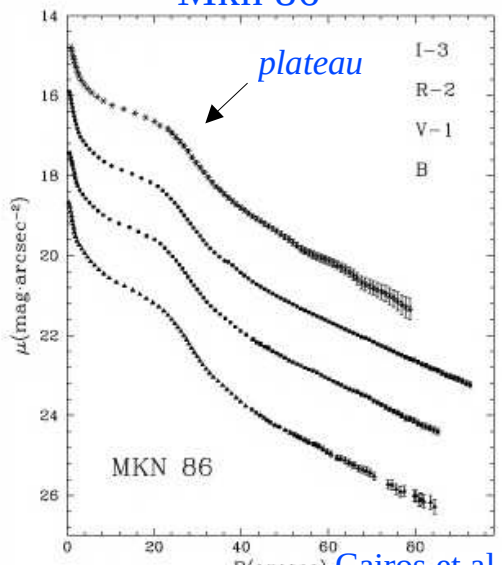
UM 465

Stellar populations in BCDs: irregular elliptical **iE** type (70%)

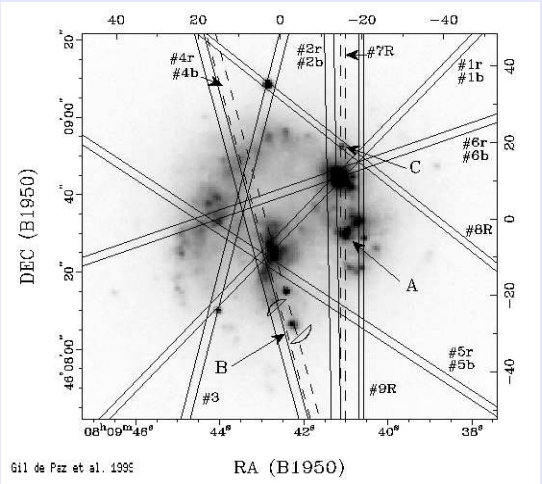
Cairos et al. (2001a)



Mkn 86

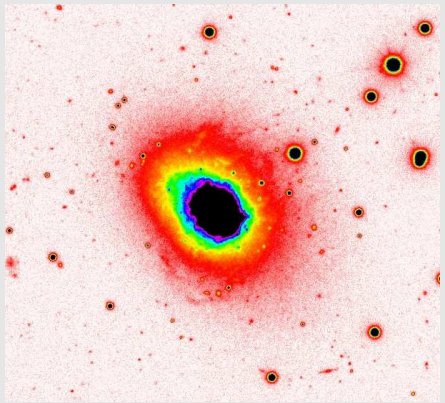


Cairos et al. (2001a)

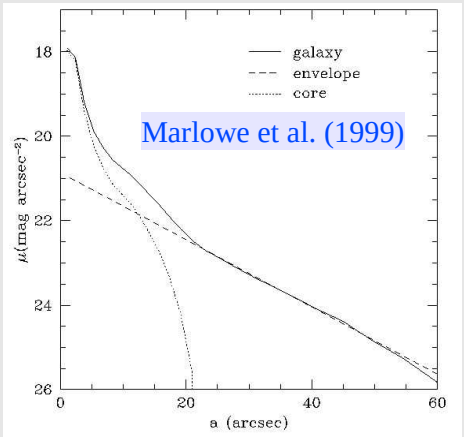


Gil de Paz et al. (1999)

plateau (Papaderos et al. 1996a)
platform (Telles et al. 1997)
core (Marlowe et al. 1997/1999)
extra component
(Doublier et al. 1999, Cairos et al. 2001a)



NGC 1705
VLT/FORS
r Gunn

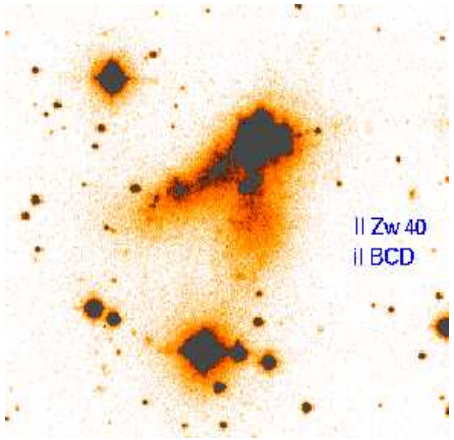


Marlowe et al. (1999)

Stellar populations in BCDs: iI or *cometary*−iI systems(<10%)

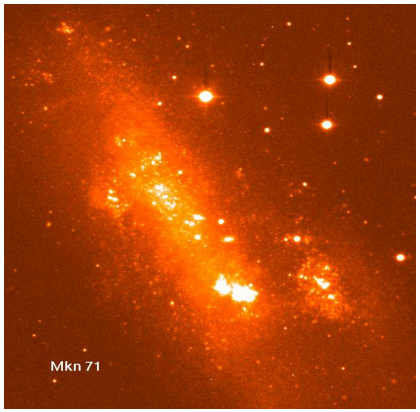
Surface brightness profiles: exponential intensity decrease at large radii

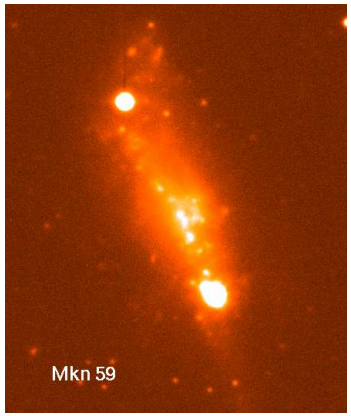
dynamics, evolutionary status and (a possible) relation to
the main class of iE/nE BCDs?



cometary iI BCDs

Intermediate stages in the BCD evolution?
(Noeske et al. 2000)

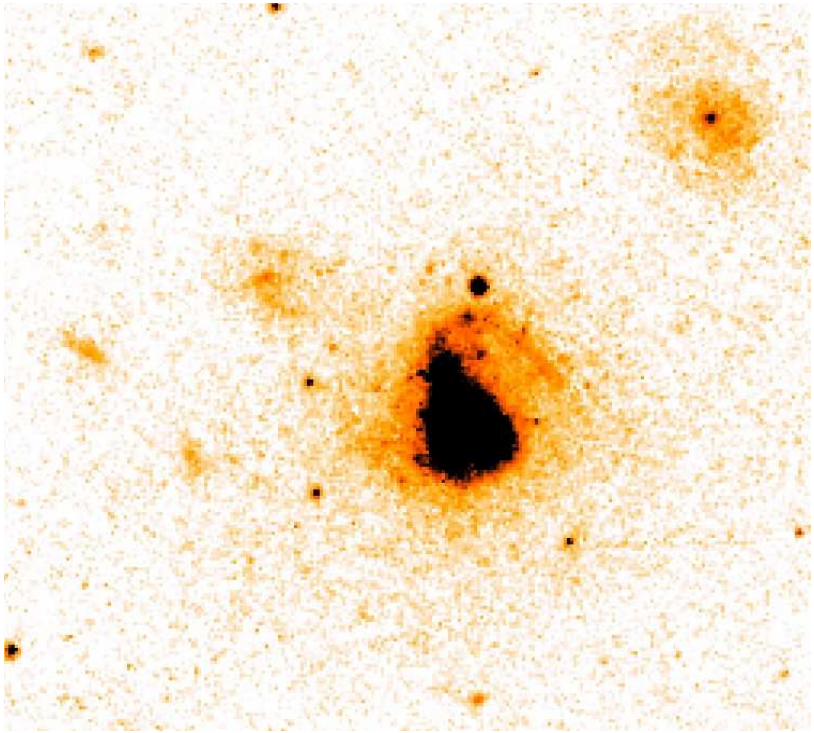




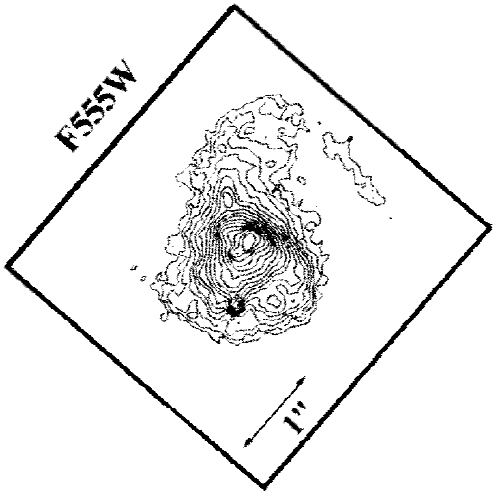


(Noeske et al. 2003)

Stellar populations in BCDs: i0 (very rare)



Corbin & Vacca (2002)

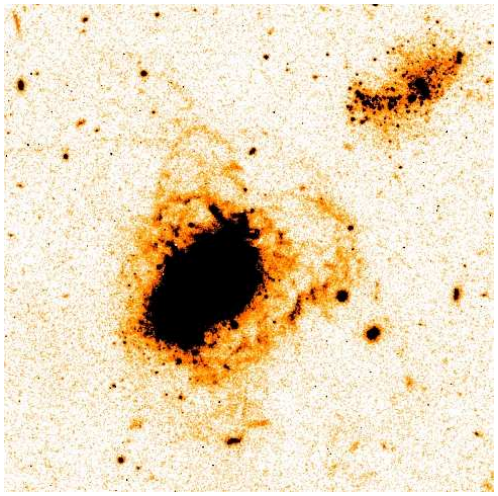


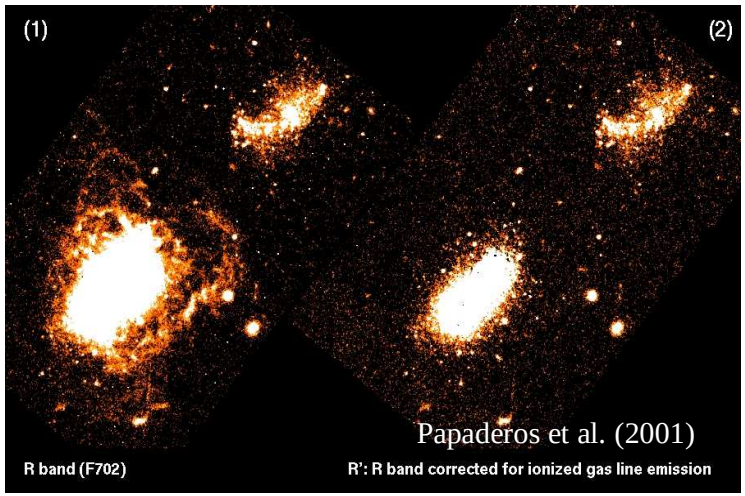
D=21 Mpc
M=−14 V mag

- ✗ only a few examples (PHL 293B, HS 0822+3542)
- ✗ no systematic studies of the stellar and gaseous component

Stellar populations in BCDs: *young*(?) i0/iI,C−BCD candidates($\ll$1%)

- ✗ severe light contamination by ionized gas emission
- ✗ *stellar* LSB population very blue (V−I$\simeq$−0.1...+0.3 mag)
- ✗ low oxygen abundance

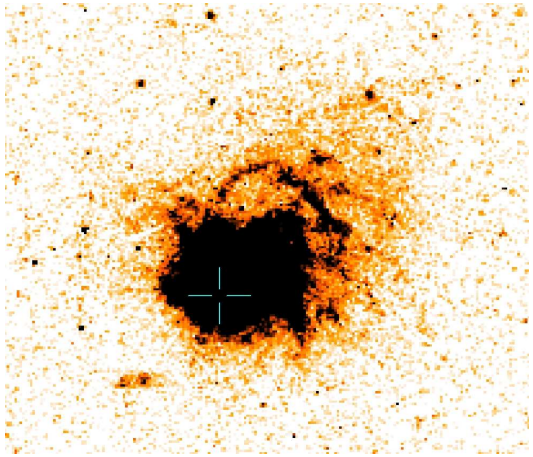




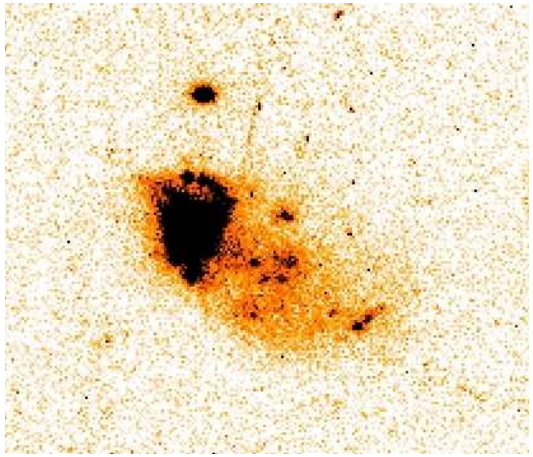
age debate ...

see, e.g.
Östlin (2000)
Kunth & Östlin (2000)

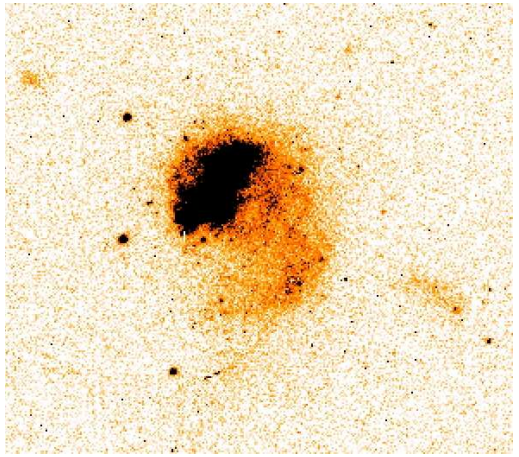
Izotov et al. (2001)
Papaderos et al. (2002)



Thuan et al. (1997), Papaderos et al. (1998)

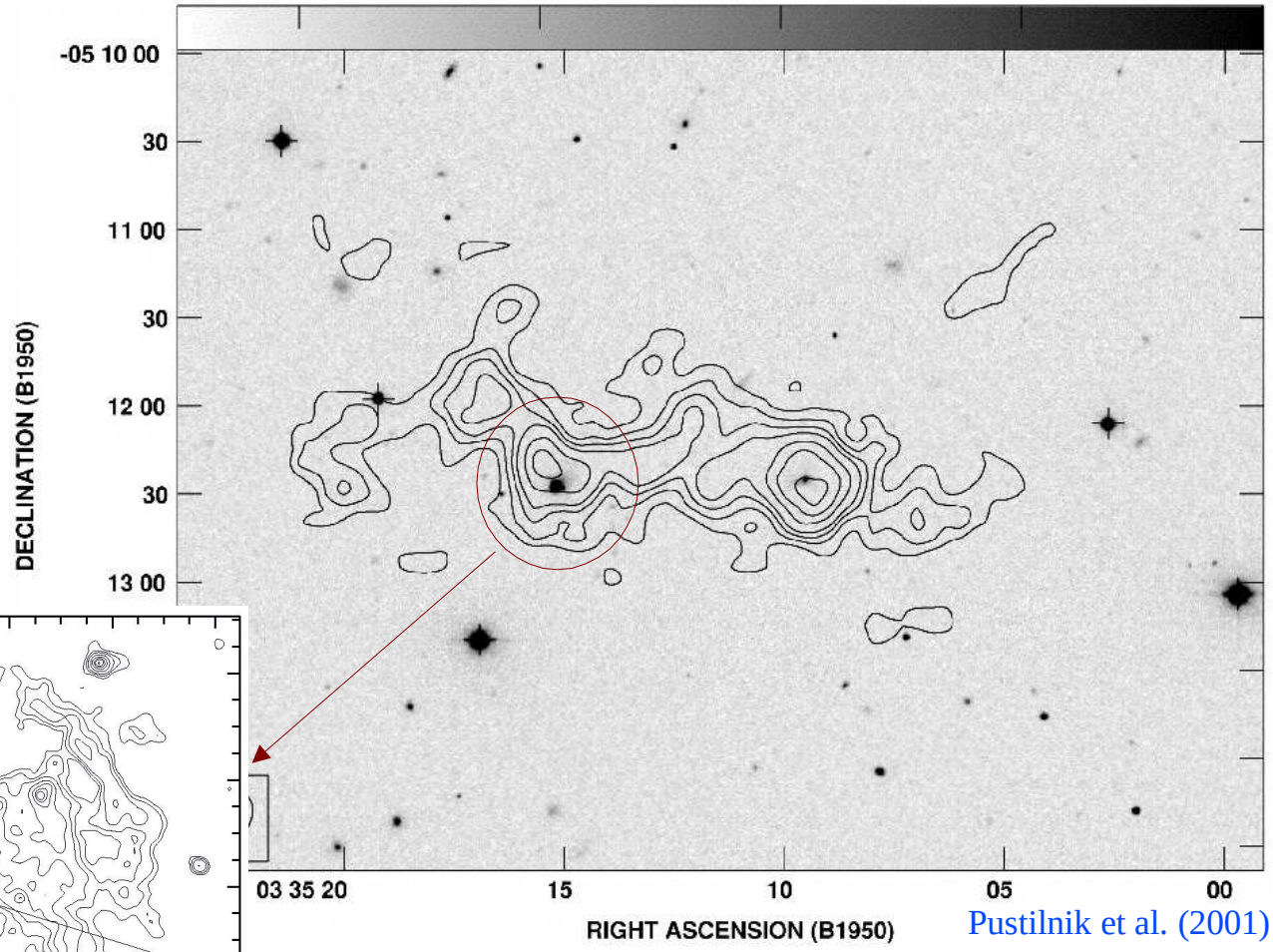


Fricke et al. (2001)

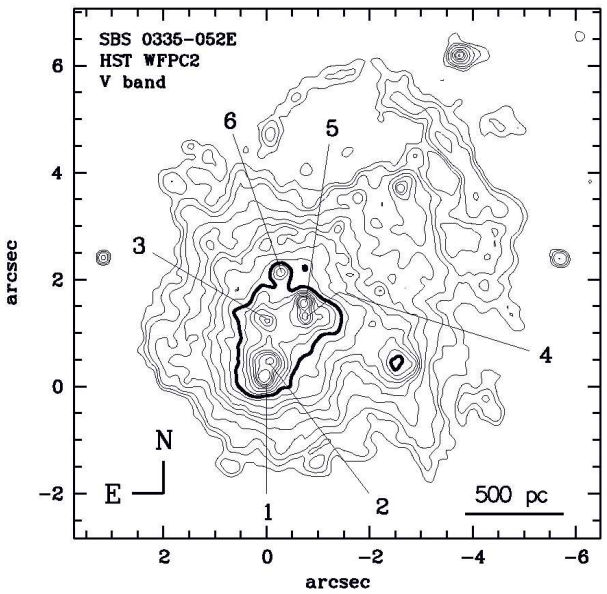


Papaderos et al. (1999)

SBS 0335−052 (E&W)



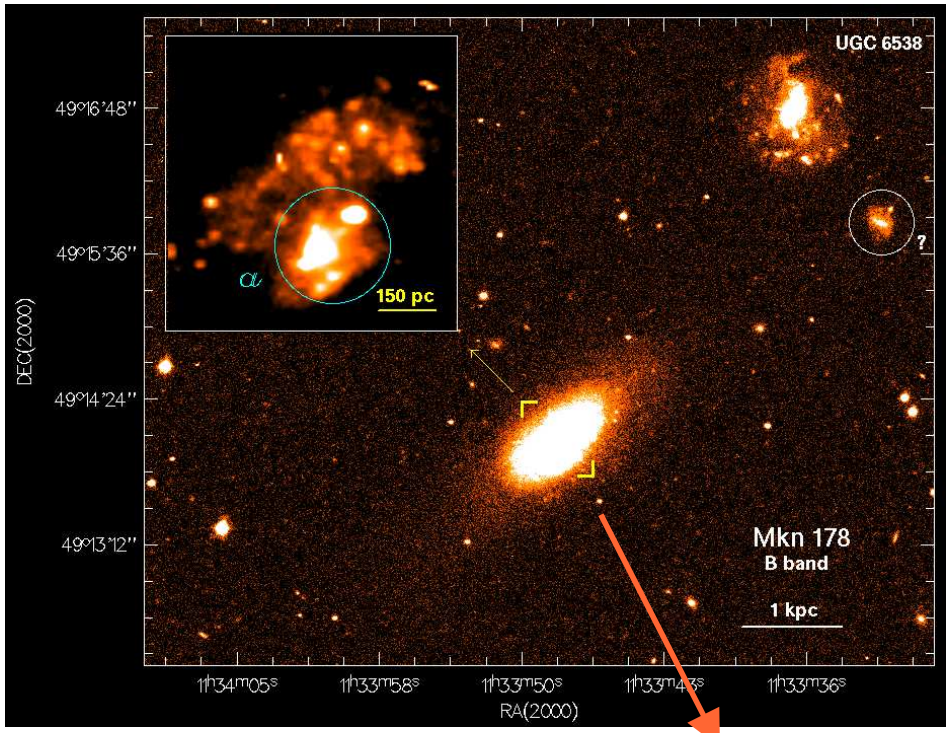
Pustilnik et al. (2001)

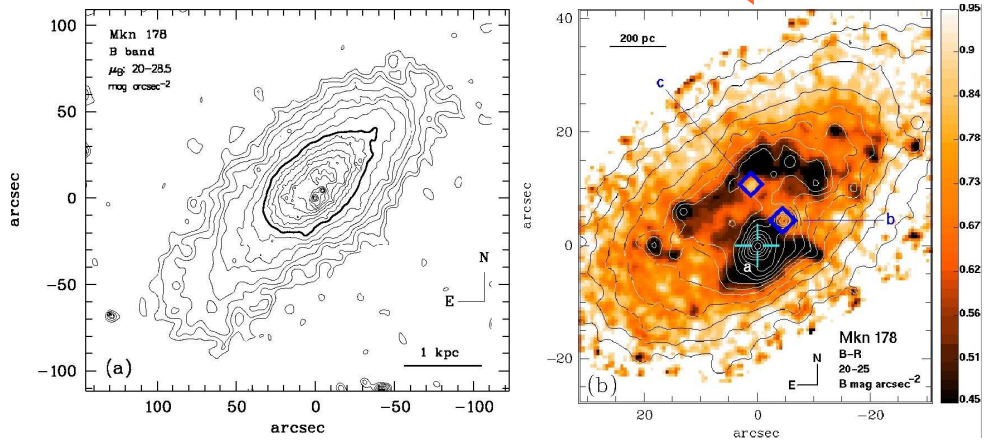


Thuan et al. (1997), Papaderos (1998)

Stellar populations in BCDs: the iE−system Mkn 178

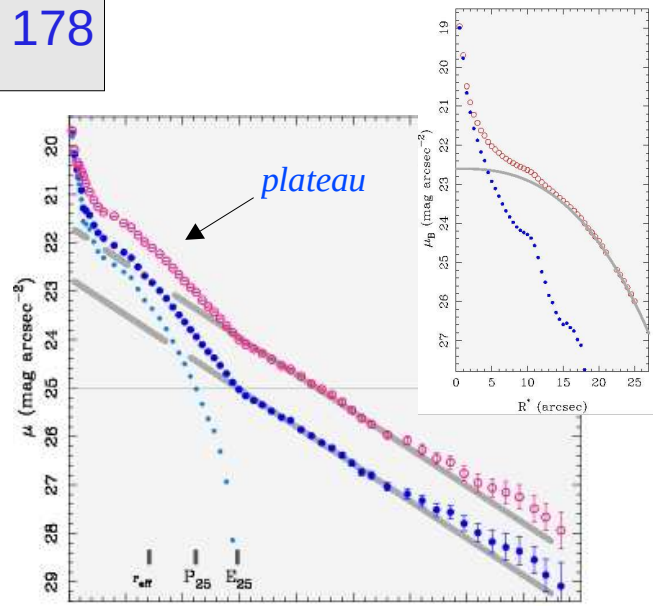
Papaderos et al. (2002)

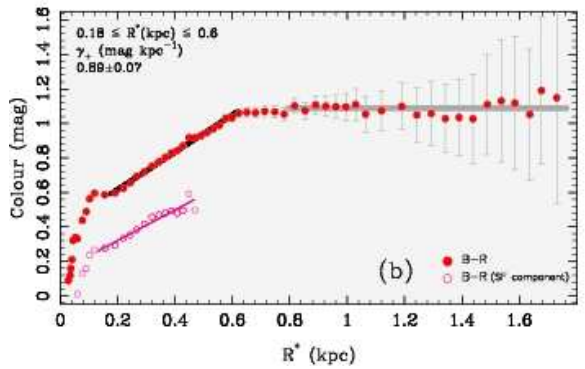




Mkn 178

D = 4 Mpc
M_B=−13.9 mag





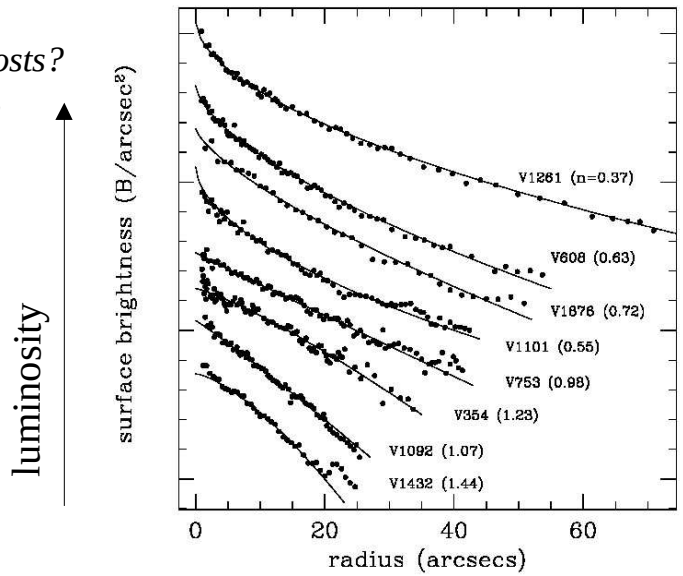
P_{25}, E_{25}: isophotal radius of the star−forming and LSB component

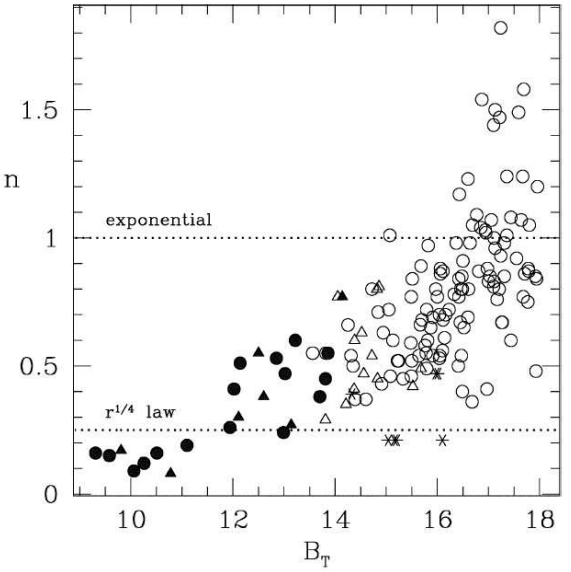
line−of−sight intensity contribution of the SF component: <40% at **P_{25}**, 4% at **E_{25}**

Subtraction of the LSB emission (model−dependent) can change colors by several 0.1 mag. Large effect on the EW of emission lines (see, e.g., Cairos et al. 2002).

LSB component: is the exponential law valid at all radii? Sersic or "type V" SBPs?

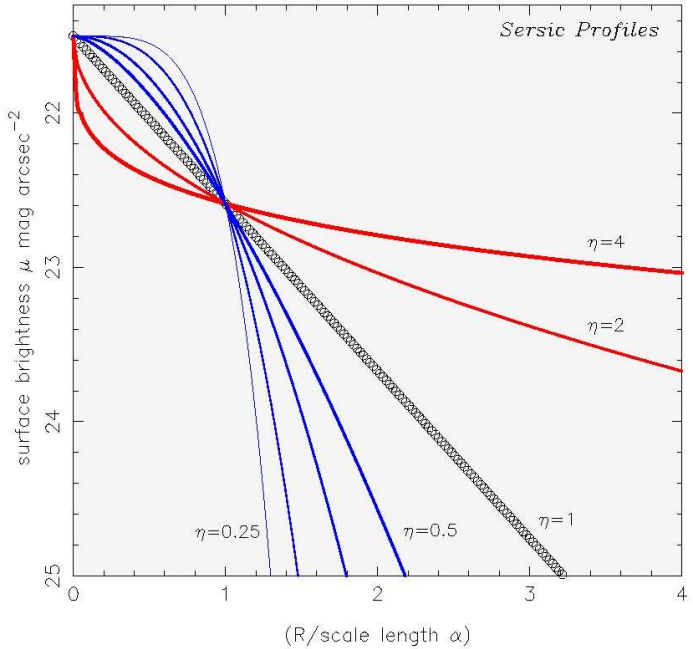
Geometry of the stellar LSB hosts?
probably triaxial ellipsoids
(Sung et al. 1998)





Binggeli & Jerjen (1998)

Sérsic (1968), Caon et al. (1993)



Intensity distribution of the form:

$$I(R) = I_0 \exp\left(\frac{R}{\alpha}\right)^{\frac{1}{\eta}}$$

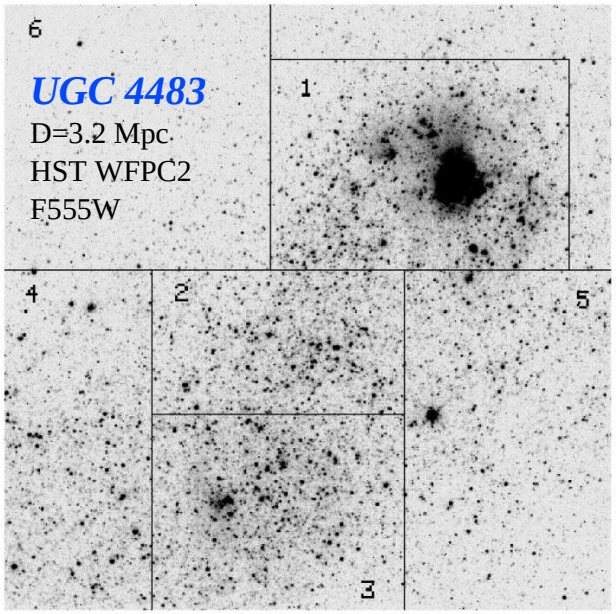
$$\mu(R) = \mu_0 + 1.086\left[\left(\frac{R}{\alpha}\right)^{\frac{1}{\eta}}\right]$$

μ_0: central surface brightness (mag/□″)
α: angular scale length (″)

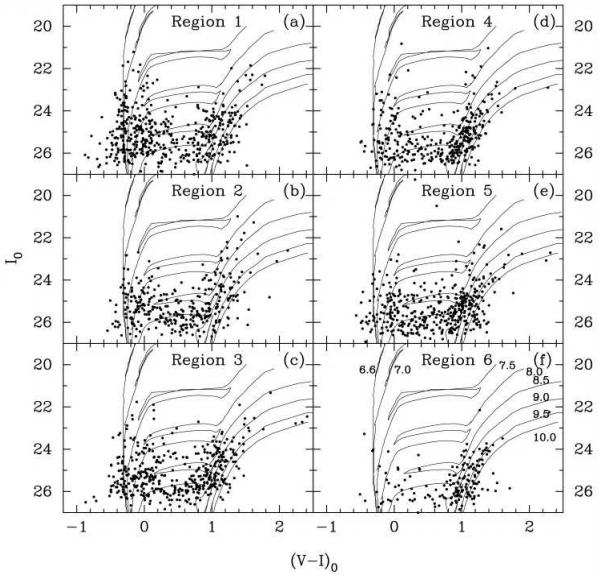
alternatively, an exponential SBP flattening at small radii (similar to "type V" SBPs in Binggeli & Cameron 1991)?

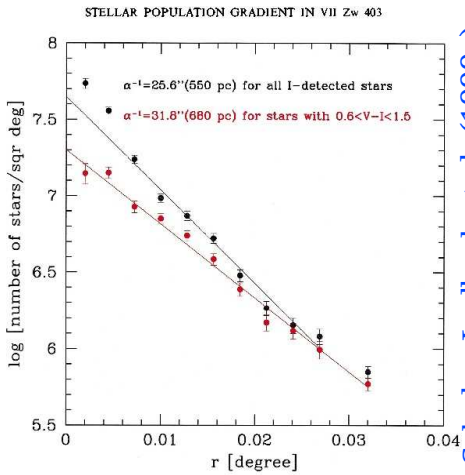
Stellar populations in BCDs: CMD studies vs. surface photometry

resolved vs. *unresolved* stellar population in BCDs (?)



Izotov & Thuan (2002)





Schulte−Ladbeck et al. (1999a)

Spatial segregation of younger stars to the cental part of the BCD (within P_{25}); red stars dominate at large radii

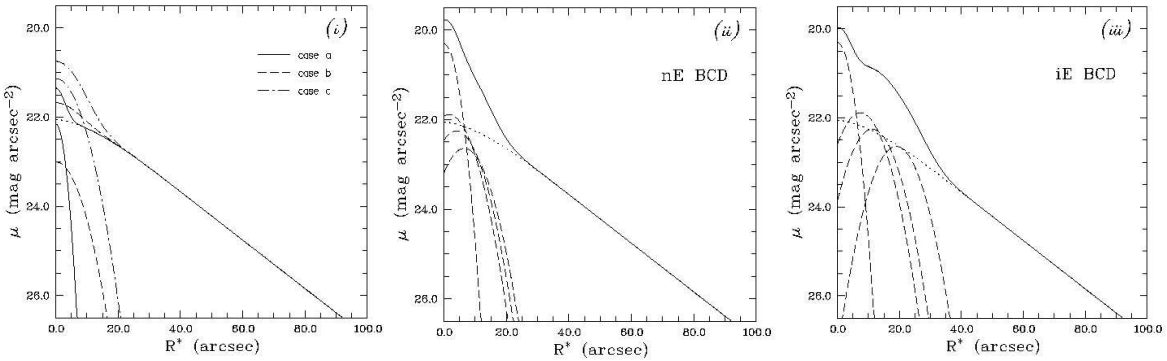
Other exampes: NGC 1705 (Tosi et al. 2001), NGC 1569 (Aloisi et al. 2001), Mkn 209 (Schulte−Ladbeck et al. 2000), UGCA 290 (Crone et al. 2002).
Similar studies for more distant BCDs based on photometry of stellar clusters (e.g., Östlin et al. 1998, ESO 338−IG04)

Stellar populations in BCDs: correspondance between morphological type and SBP?

size of the SF component

several hundred pc (Meurer et al. 1992, P96b, Telles et al. 1997, Cairos et al. (2001b)

weak SF activity | nE−BCD | iE−BCD

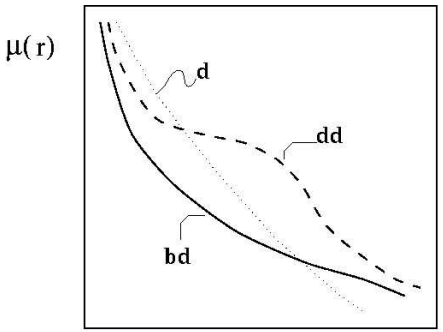


exponential | de Vaucouleurs | composite

Doublier/Cairos Papaderos et al. (1996b)

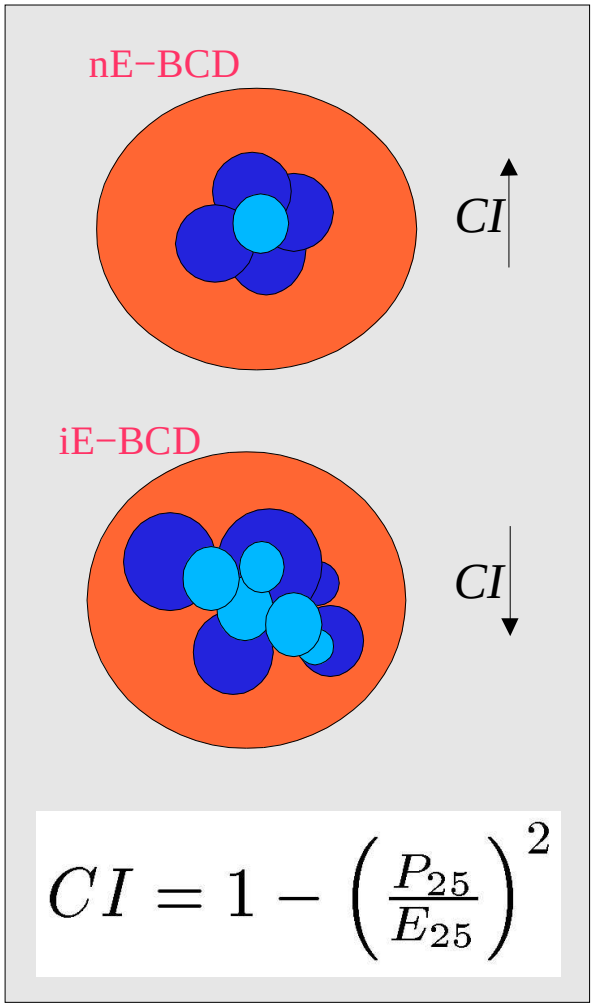
Telles

d | bd | dd



Telles et al. (1997)

morphological transition from the nE− type to the iE−type



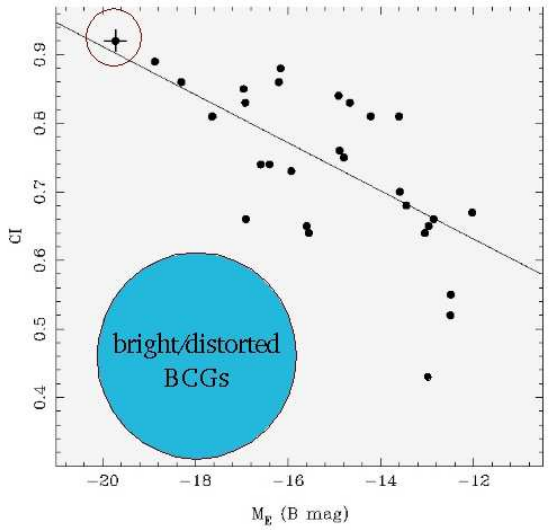
Stellar populations in BCDs: star−forming vs. LSB component

$P_{25} \simeq E_{25}/2 \ (\simeq 2a)$

CI increases with decreasing M_{LSB}

mass−morphology connection?

The gravitational potential formed by the stellar LSB component influences the star−forming process



Instrinsically luminous/ distorted BCGs (e.g. Mkn 1089)

other star−forming dwarf galaxies **(?)**

- ✗ Spatial properties of SF in dIs (Youngblood & Hunter 1999)
- ✗ van Zee 2001: connection between central surface brightness of the LSB component and SFR per unit area

Stellar populations in BCDs: evolutionary connections with, e.g., dwarf irregulars (?)

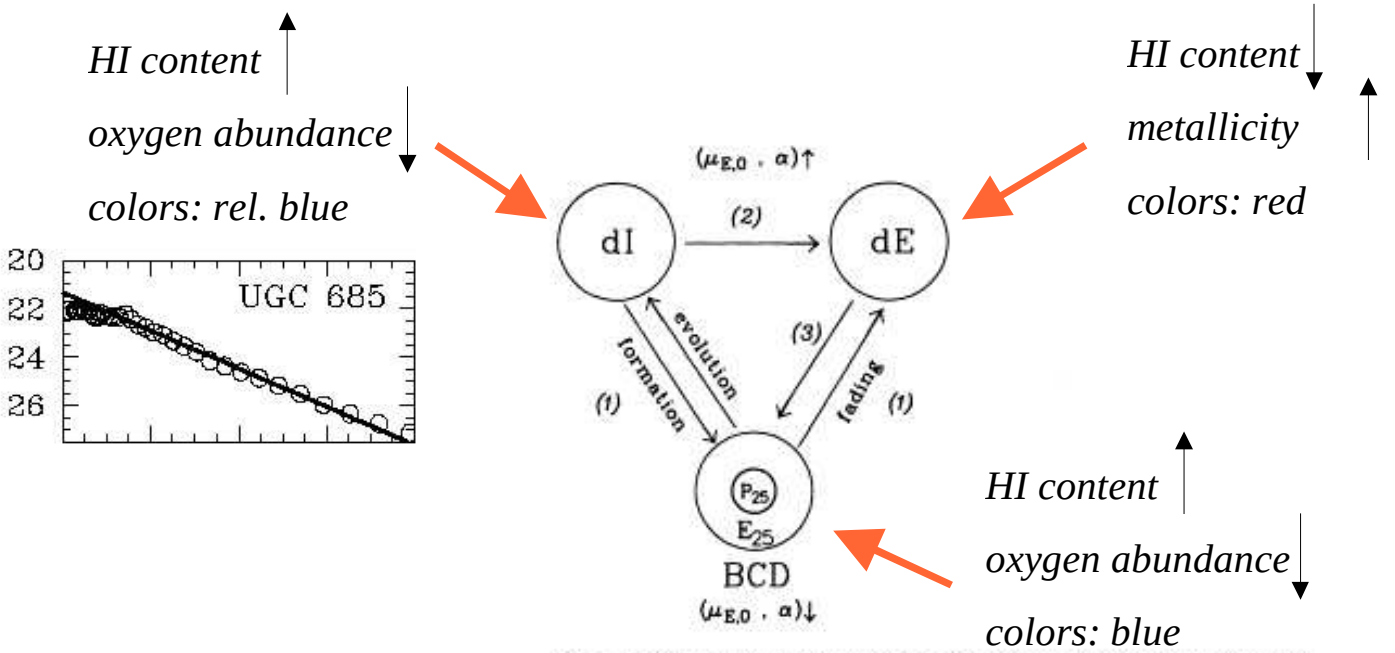
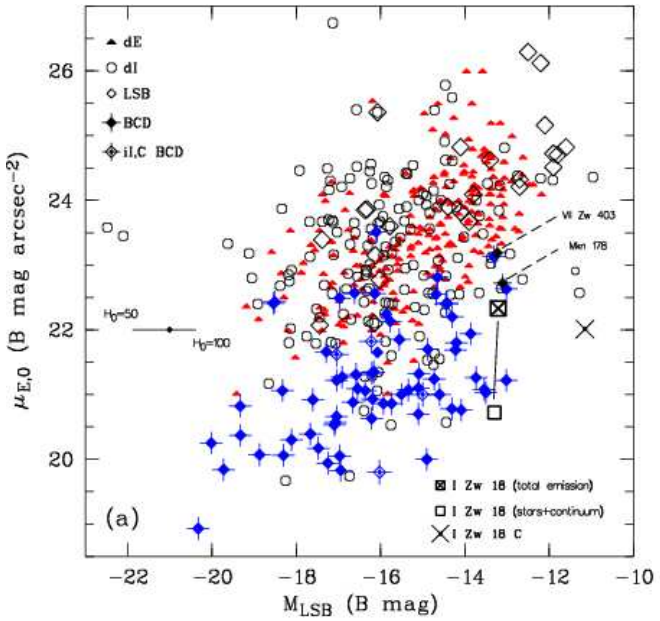
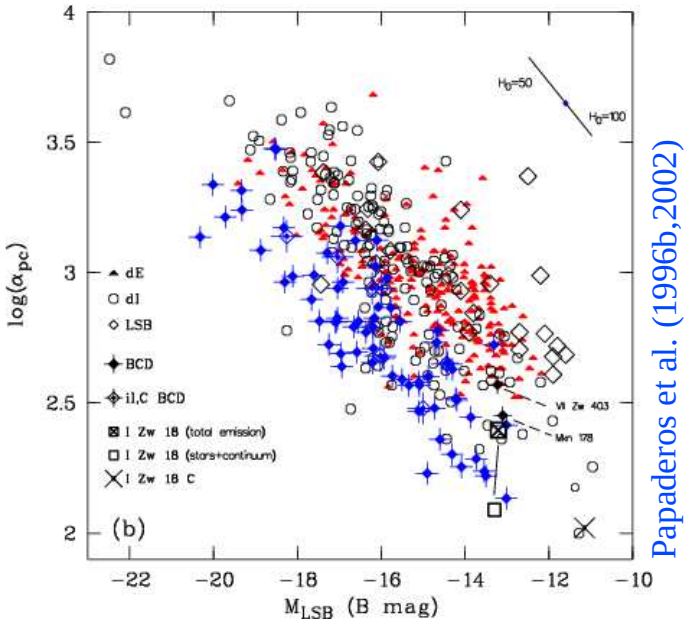


Fig. 13. Schematic representation of various evolutionary scenarios between dIs, BCDs and dEs: (1) dI ⇆ BCD → dE (Thuan 1985, Davies & Phillipps 1988), (2) dI → dE (Lin & Faber 1983), (3) dE → BCD (Silk et al. 1987).

Hypothesis: if BCDs are a few Gyr old dIs, seen during an active phase, then the stellar LSB host in both types of dwarf galaxies should have comparable structural properties (e.g., central surface brightness, exponential scale length).

Stellar populations in BCDs: comparison of the structural properties of their LSB host galaxy

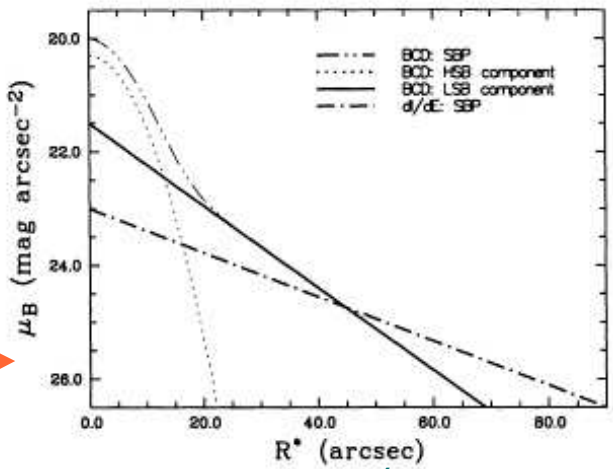




Papaderos et al. (1996b,2002)

Only small overlap between BCDs and dIs in diagrams (a) and (b)

At equal absolute B magnitude the stellar LSB host galaxy of BCDs is more compact than in dIs (and dEs)



The neutral hydrogen content of BCDs

- single−dish observations available for a large sample of neaby BCDs/BCGs

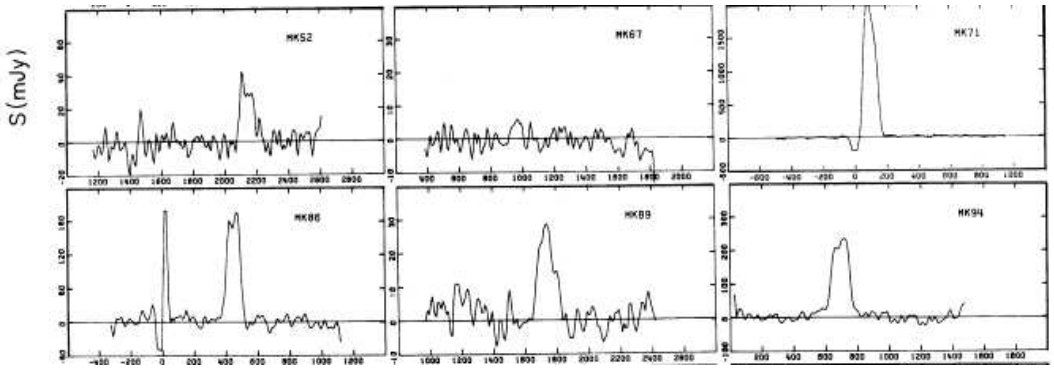
(Thuan & Martin 1981, Gordon & Gottesman 1981, Staveley−Smith et al. 1992, etc.)

- mass ratio: typically M_{HI}/M_T: 0.3−0.8, M_T/L_B=2−6

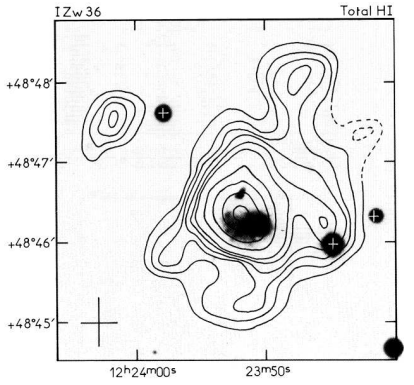
- only a few BCDs have been interferometrically maped in the 21cm line

(Balkowski et al. 1978, Viallefond & Thuan 1983, van Zee et al. 1998, 2001, Putman et al. 2001, Simpson & Gottesmann 2000)

- $$\frac{\text{HI radius}}{\text{optical radius}} \sim 3\ldots10$$



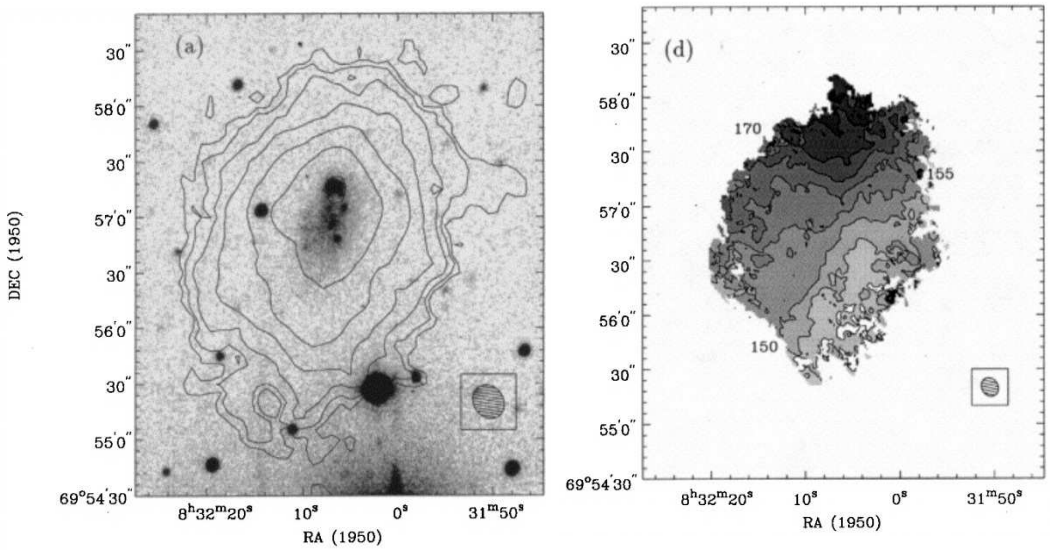
$$F_H = 2.36 \times 10^5 \int Sdv\, M_\odot\, \mathrm{Mpc}^{-2}, \qquad (11)$$



Viallefont & Thuan (1983)

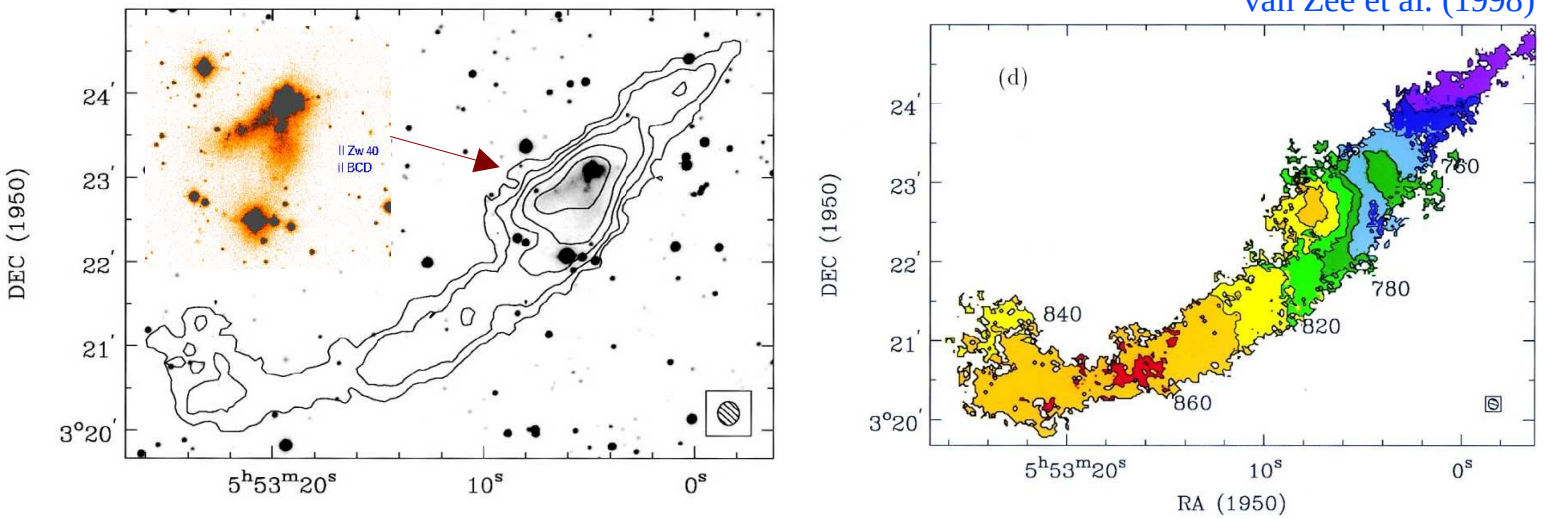
HI properties of BCDs

UGC 4483



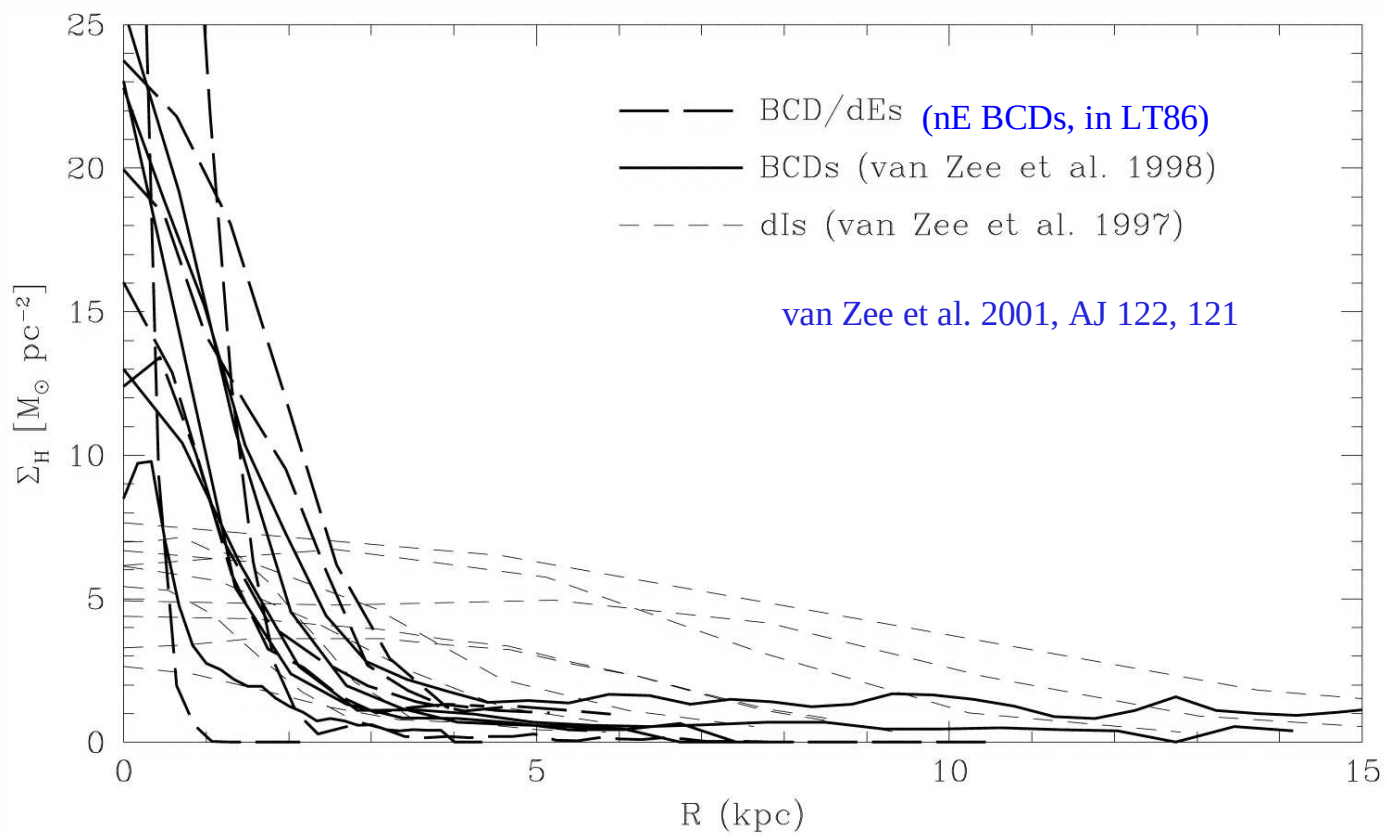
II Zw 40

van Zee et al. (1998)



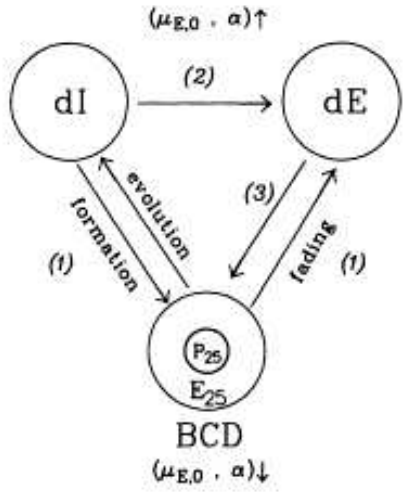
The HI properties of BCDs

Radial HI surface density distribution in BCDs and dIs

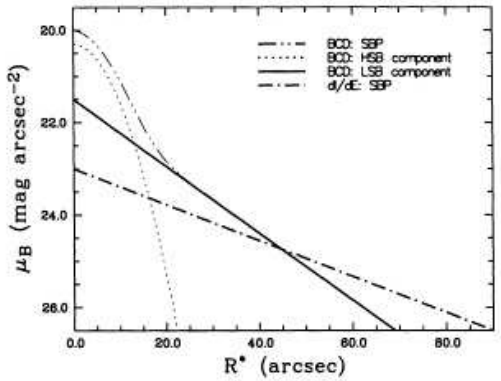


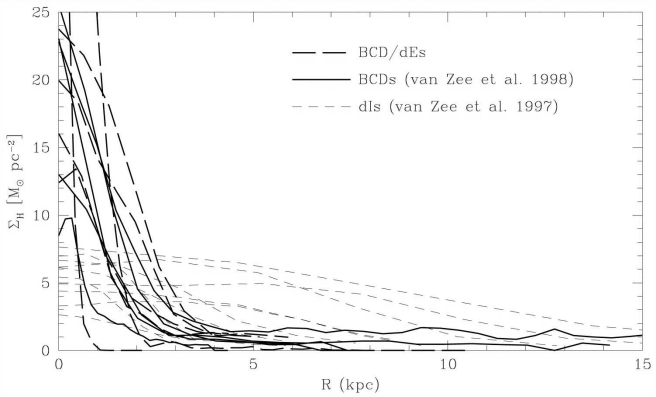
$$\Sigma_{HI}(\text{BCDs}) \sim 5 \times \Sigma_{HI}(\text{dIs})$$

Evolutionary Connections between BCDs and other dwarf galaxies?



?





Interpretations (?)

$$\psi^{i}_{R_{\rm Ho}} = \frac{M_{\rm DM}}{M_L} = \frac{M_{\rm DM}}{\rm Stars+Gas}$$

case I: Dark Matter (DM) dominates ***within*** the optical size of a BCD:
no BCD−dI evolutionary connection

case II: Dark Matter does not invariably dominate ***within*** the optical size of a BCD: BCD−dI evolutionary transition *may* be possible

(?) dynamical response of the stellar LSB host galaxy to a redistribution of mass within the Holmberg radius (for instance, adiabatic contraction of the stellar LSB component prior to the onset of a burst, in response to a large−scale gas−infall and vice versa).

(Papaderos et al. 1996b)

Do BCDs form and evolve within a very dense DM halo dominating the mass at all radii? (Meurer et al. 1998)

Questions?

- Parameters influencing the SF process on large scales? Nature of the radius P_{25} of the star−forming component (?)
- Star Formation History within P_{25}
- radial intensity and density distribution of the LSB host galaxy within P_{25}
- Environment
- Kinematical and thermodynamic properties of the ISM
- Dark Matter distribution ***within*** the optical size of a BCD?

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