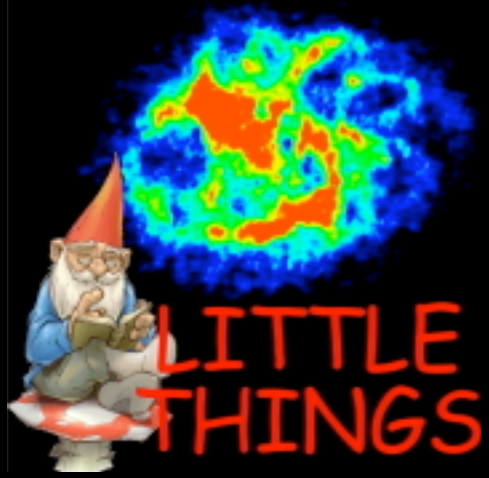
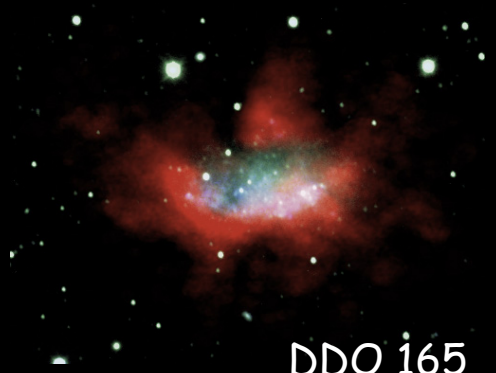
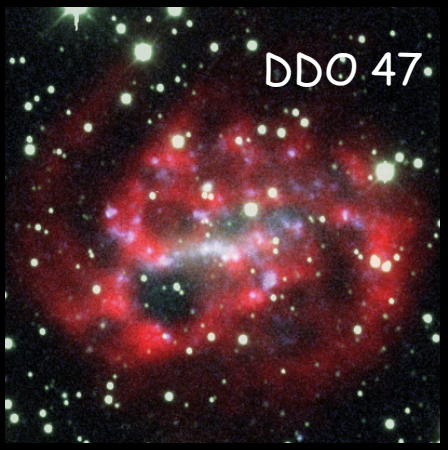


DDO 133



DDO 165

Stellar Surface Brightness Profile Breaks of Dwarf Galaxies



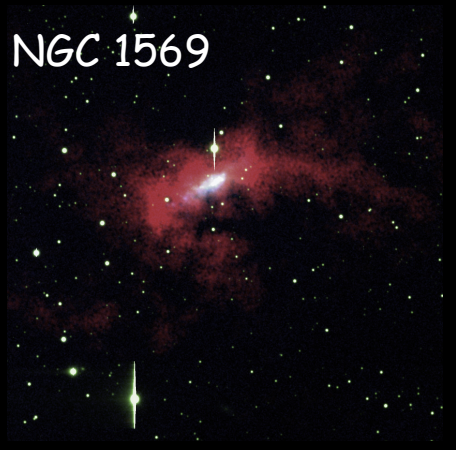
DDO 47

Kim Herrmann
Penn State Mont Alto

With Deidre Hunter & Bruce Elmegreen

Formation and Evolution of
Exponential Disks in Galaxies

October 7, 2014



NGC 1569

(Images: LT team and Lauren Hill)

A Riddle

Look at a galaxy! Its disk light

Falls exponentially- is that right?

If you look deeply, often you'll see

Signs of us- in both Types II and III!

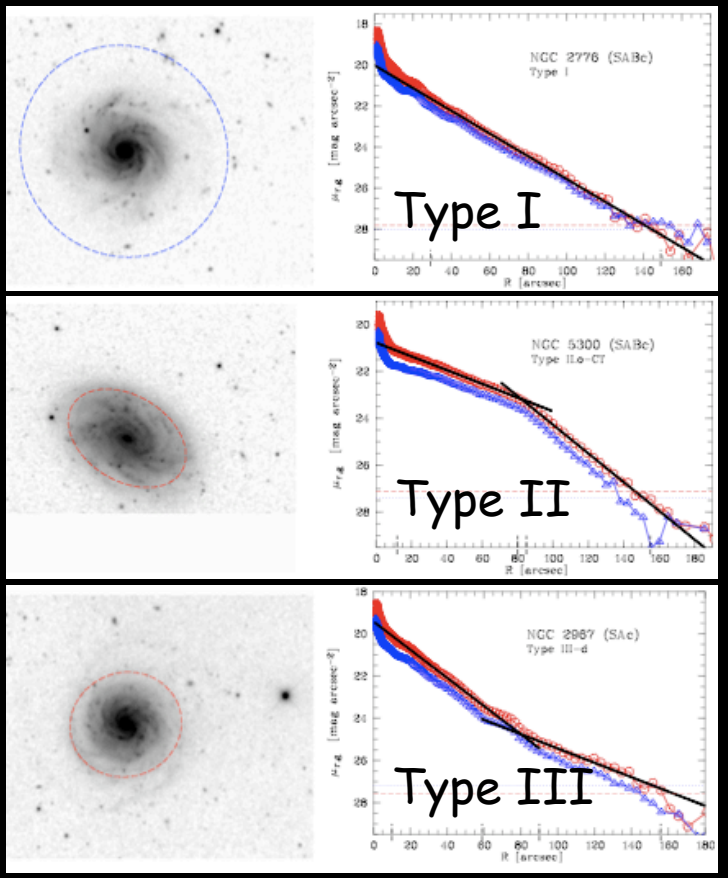
Why do we exist? Explore the gas,

Motions near and far. Profile the mass.

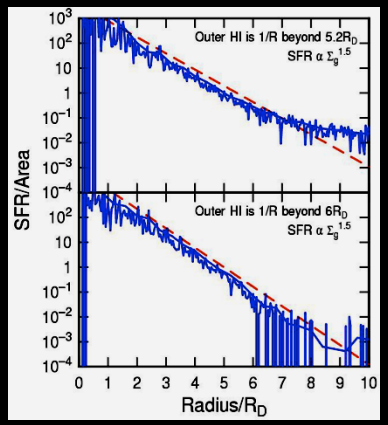
Search with care; do whatever it takes.

We are Surface Brightness Profile Breaks!

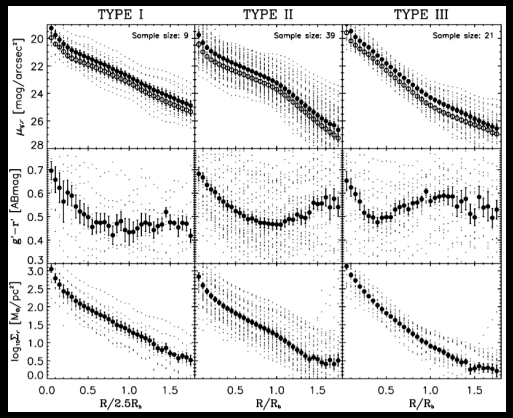
(Pohlen & Trujillo 2006, PT06)

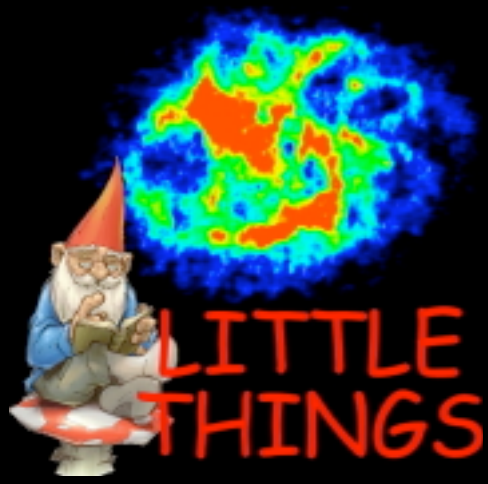


(Bakos et al. 2008)



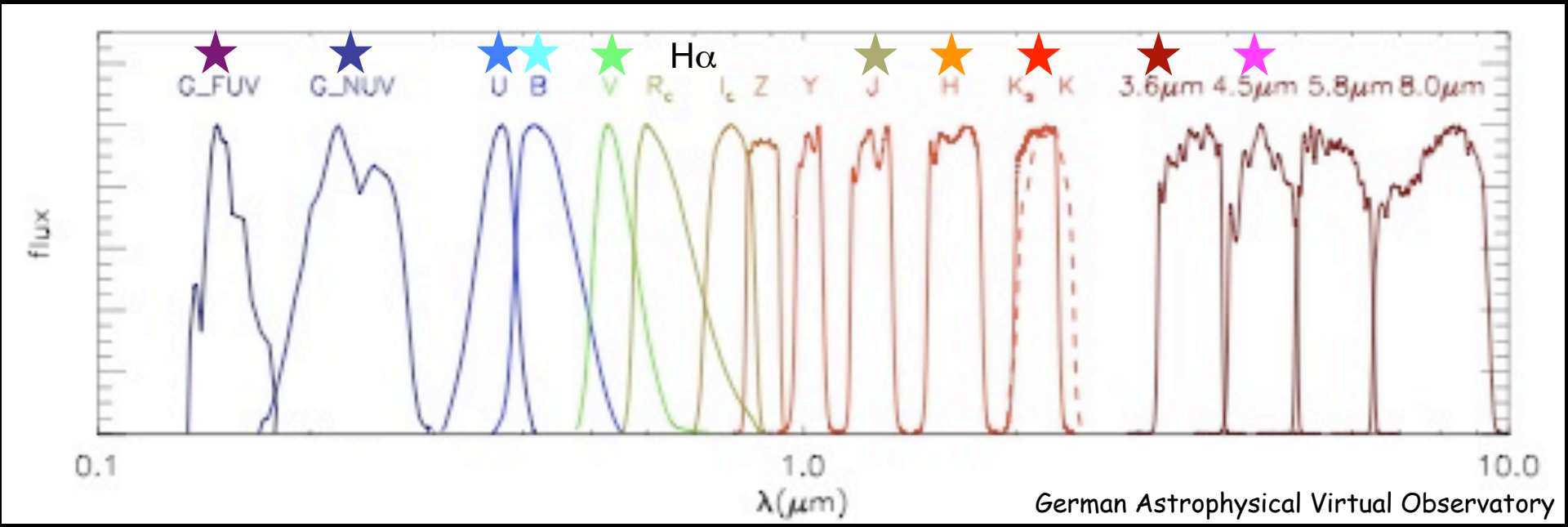
(Elmegreen & Hunter, 2006)





The Sample and Fitting

- 141 Dwarfs (parent sample for LITTLE THINGS):
  - 96 dIms, 26 BCDs, 19 Sms
- ≤ 11 passbands
- 776 profiles!



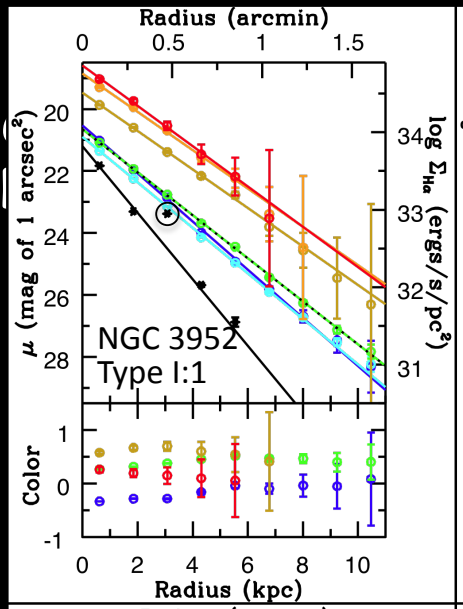
The Sample and Fitting

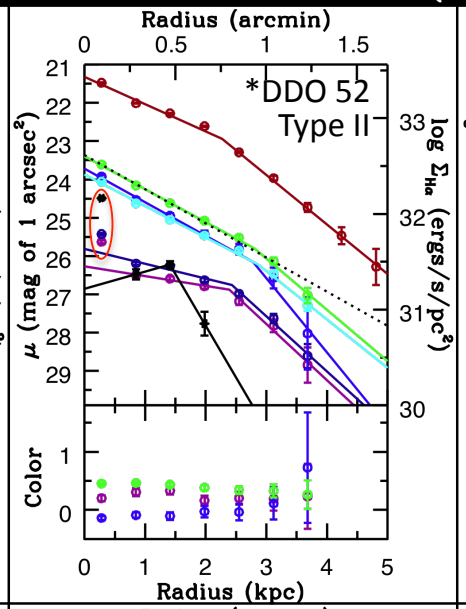
(Herrmann et al. 2013, Paper I)

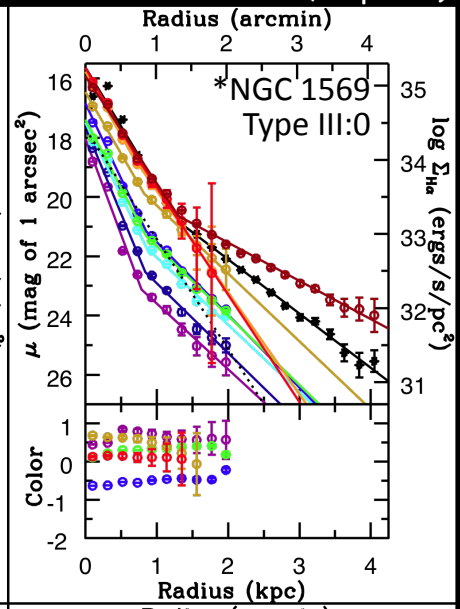
- 141 Dwarfs (par
  - 96 dIms, 26 BCI
- ≤ 11 passbands
- 776 profiles!

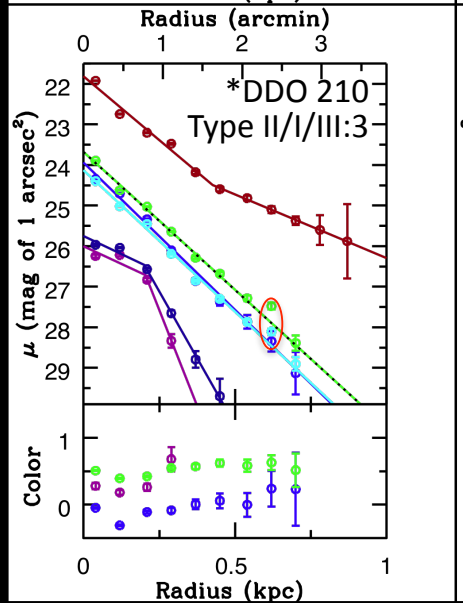
μ	Color
FUV	FUV – NUV
NUV	
U	U – B
B	
V	B – V
Hα	
J	J – H
H	
K	H – K
3.6 μm	
4.5 μm	3.6 μm – 4.5 μm

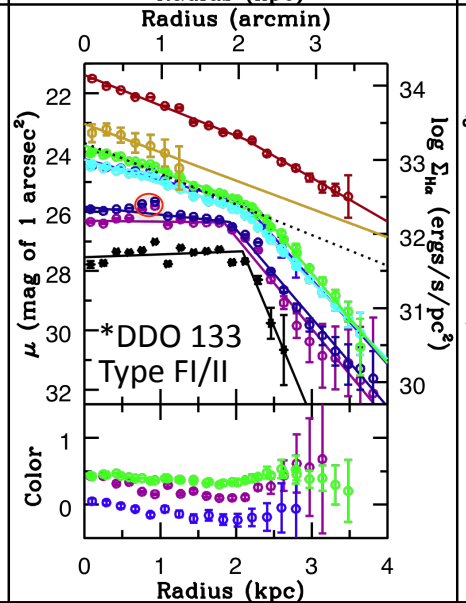
(Hunter & Elmegreen 2004, 2006; Hunter et al. 2006, 2010, 2011, Zhang et al. 2012 + Spitzer Legacy projects)

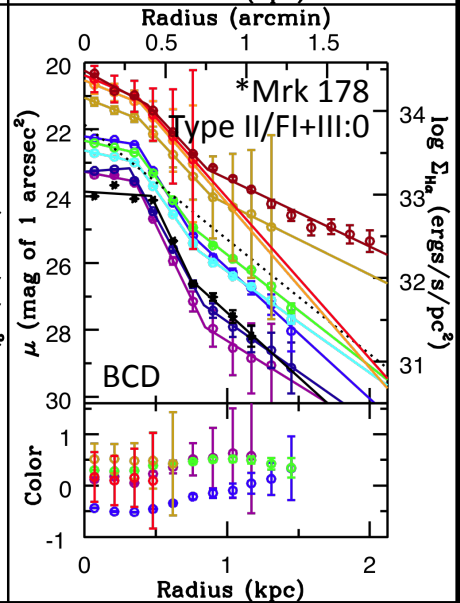






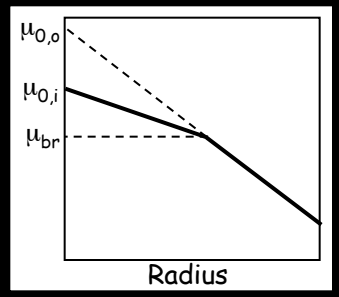






Are there trends?
$\mu_{0,i}$, $\mu_{0,o}$, & μ_{br}

(Herrmann et al. 2013, Paper I)



Central Surface Brightness, $\mu_{0,i}$ (inner fit)

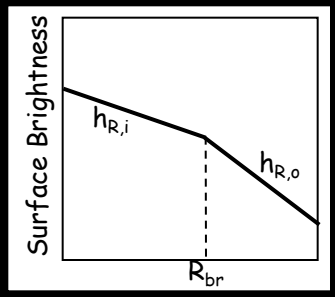
Outer Surface Brightness Projected to Center, $\mu_{0,o}$

Surface Brightness at Break, μ_{br}

(spiral data from PT06)

Are there trends?
$h_{R,i}$, $h_{R,o}$, R_{br}

(Herrmann et al. 2013, Paper I)

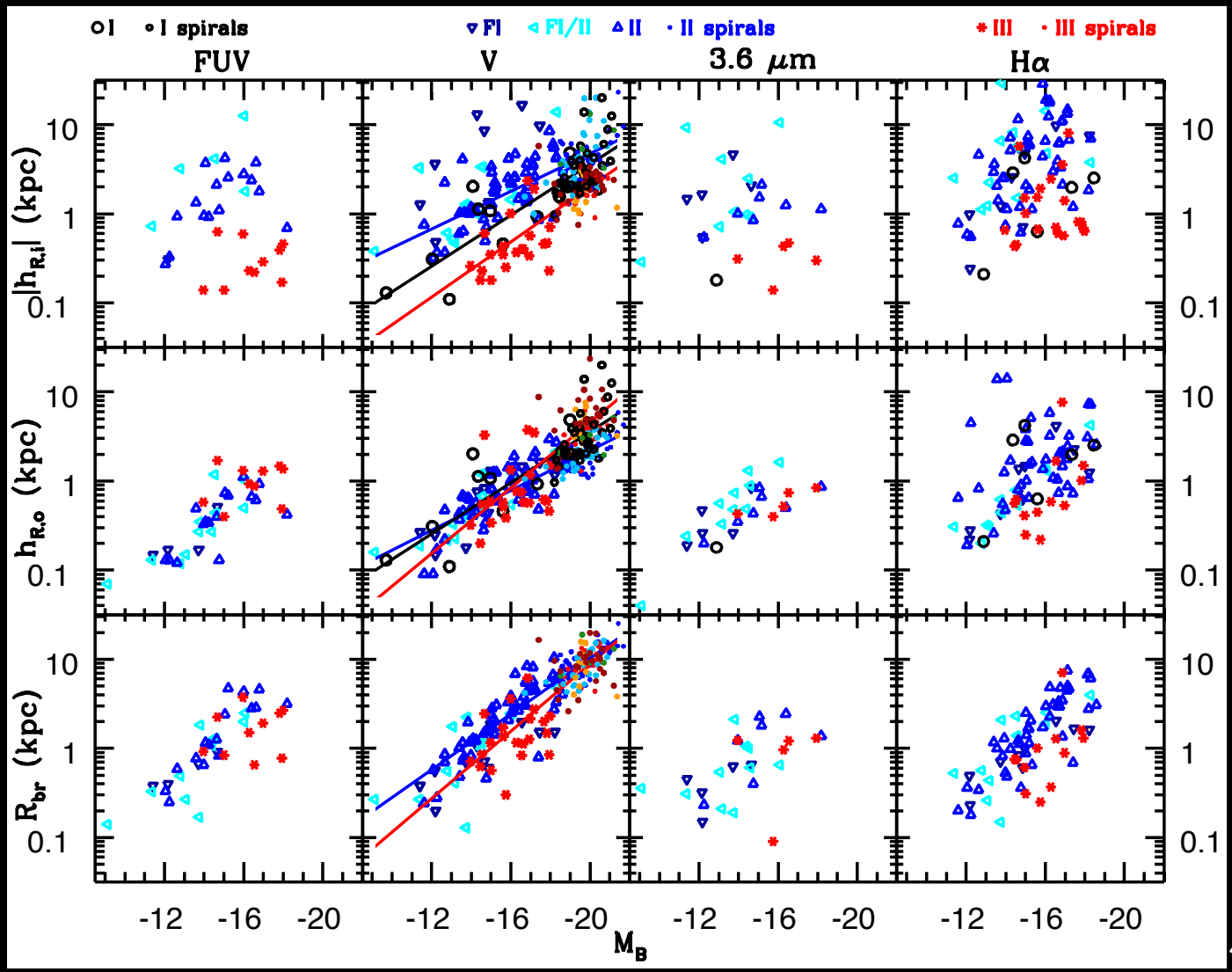


|Inner scale length| $h_{R,i}$ (kpc)

Outer scale length $h_{R,o}$ (kpc)

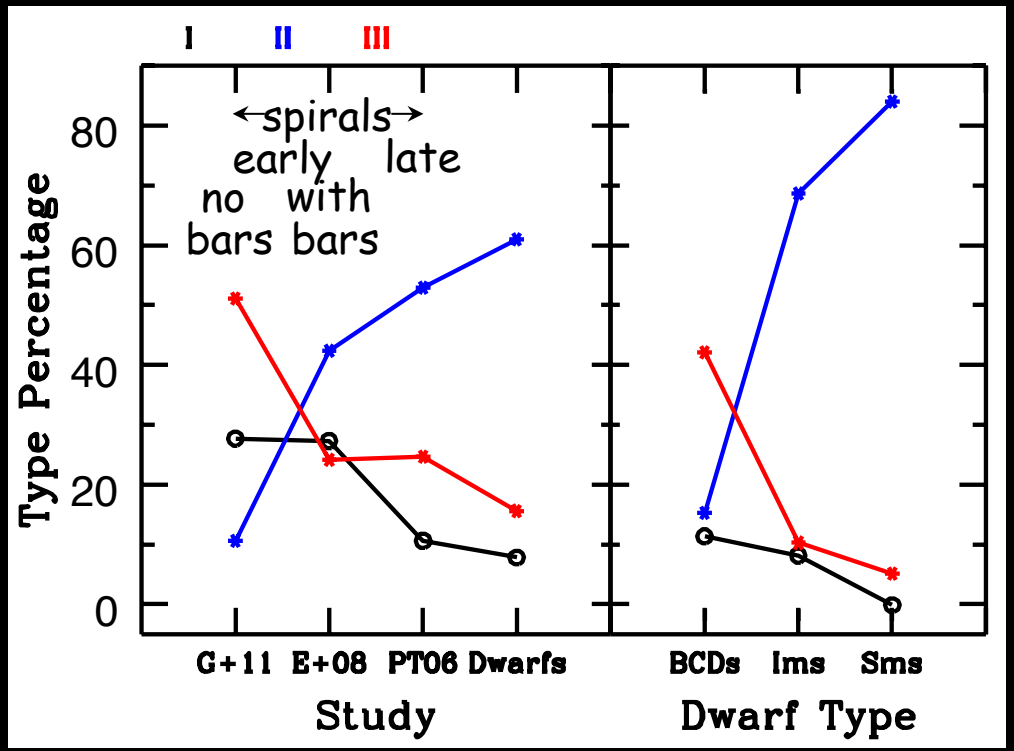
Break location R_{br} (kpc)

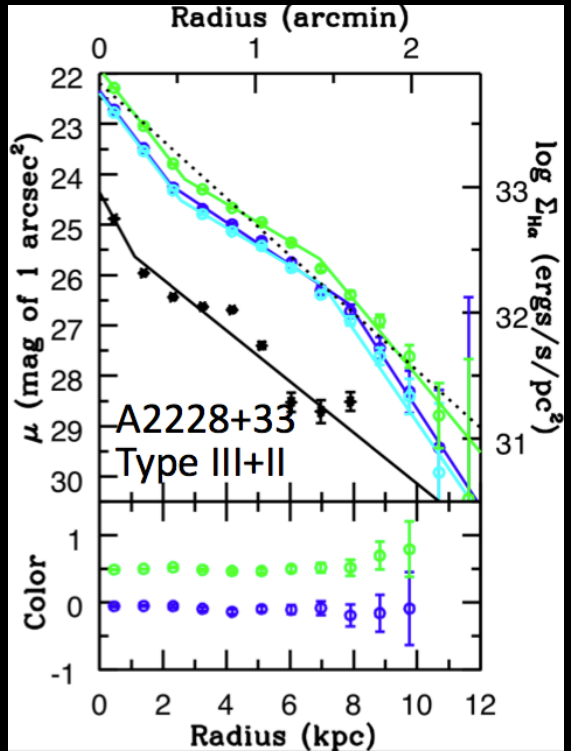
(spiral data from PT06, E+08, G+11; Erwin+ 2008, Gutiérrez+ 2011)

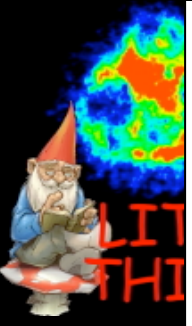


Highlights from Paper I: Profiles and Statistics

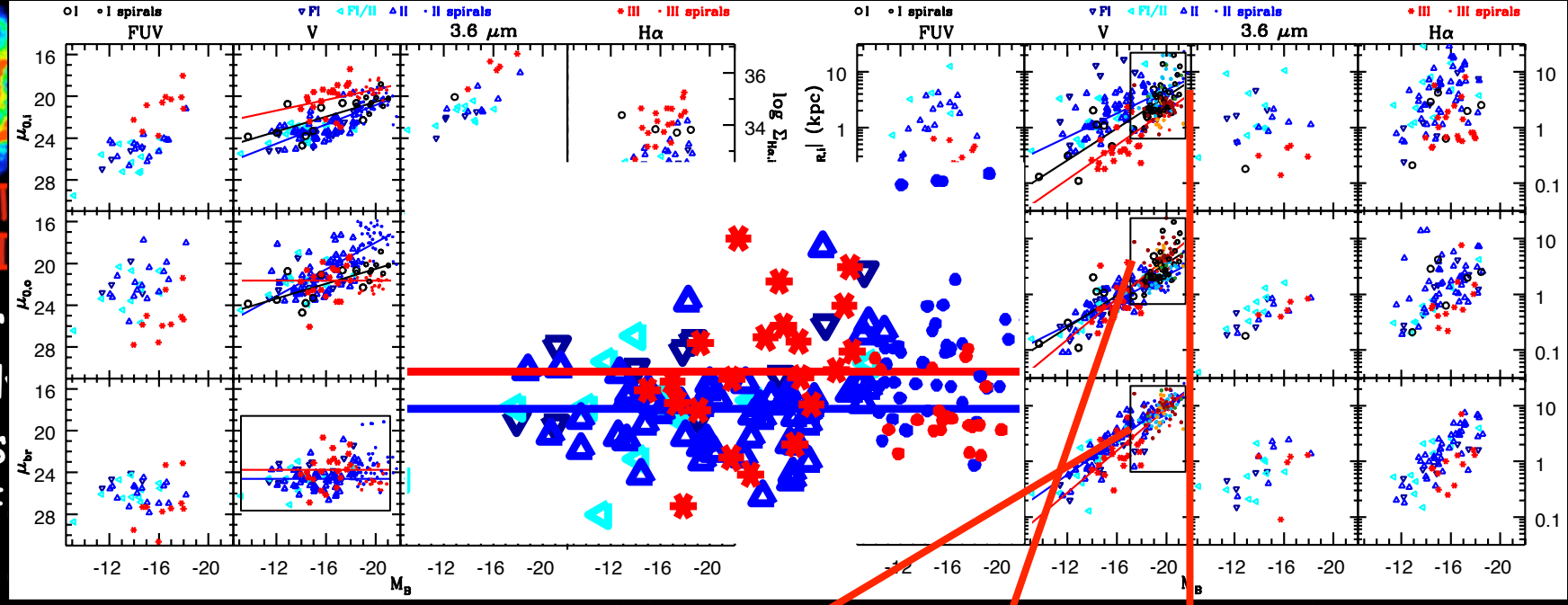
- Dwarfs extend the Profile Type trends with Hubble type
  - Early-types: more IIIs and Is; Late-types: more IIs
- BCDs & Sms are over-represented as Types III and II, respectively
- We found four Type III+II profiles & 13 multi-profile type dwarfs
- Bars and peculiar morphologies appear to have no influence on types



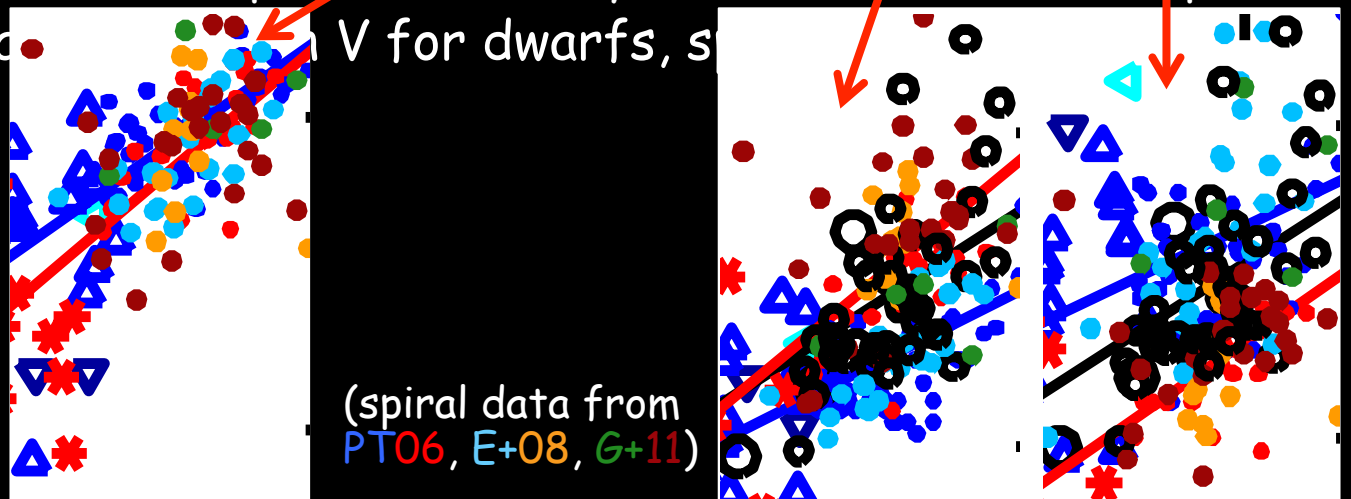




- Dwar
  - Earl
- BCDs
- We f
- Bars

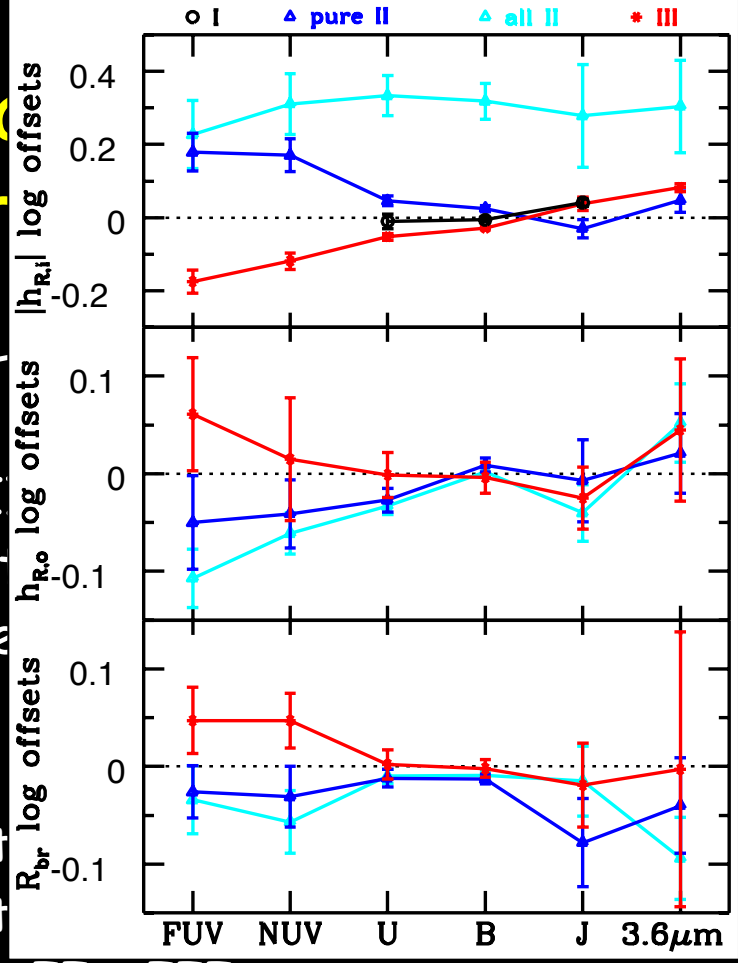


- More luminous -> brighter $\mu_{0,i}$, larger $h_{R,i}$, $h_{R,o}$, R_{br}; dwarf & spiral trends
- Between IIs and IIIs:
  - Dwarfs: similar outer parameters; very different inner parameters; $R_{brII} \sim 2R_{brIII}$
  - Spirals: similar break parameters; very different outer & inner parameters
- μ_{br} ~ 24 mo … V for dwarfs, s…



(spiral data from PT06, E+08, G+11)

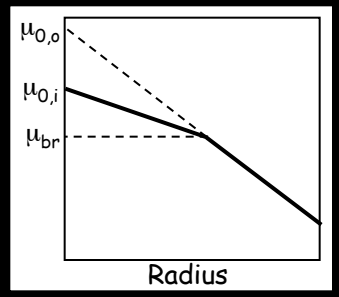
Highlights from P
Profiles and Stat

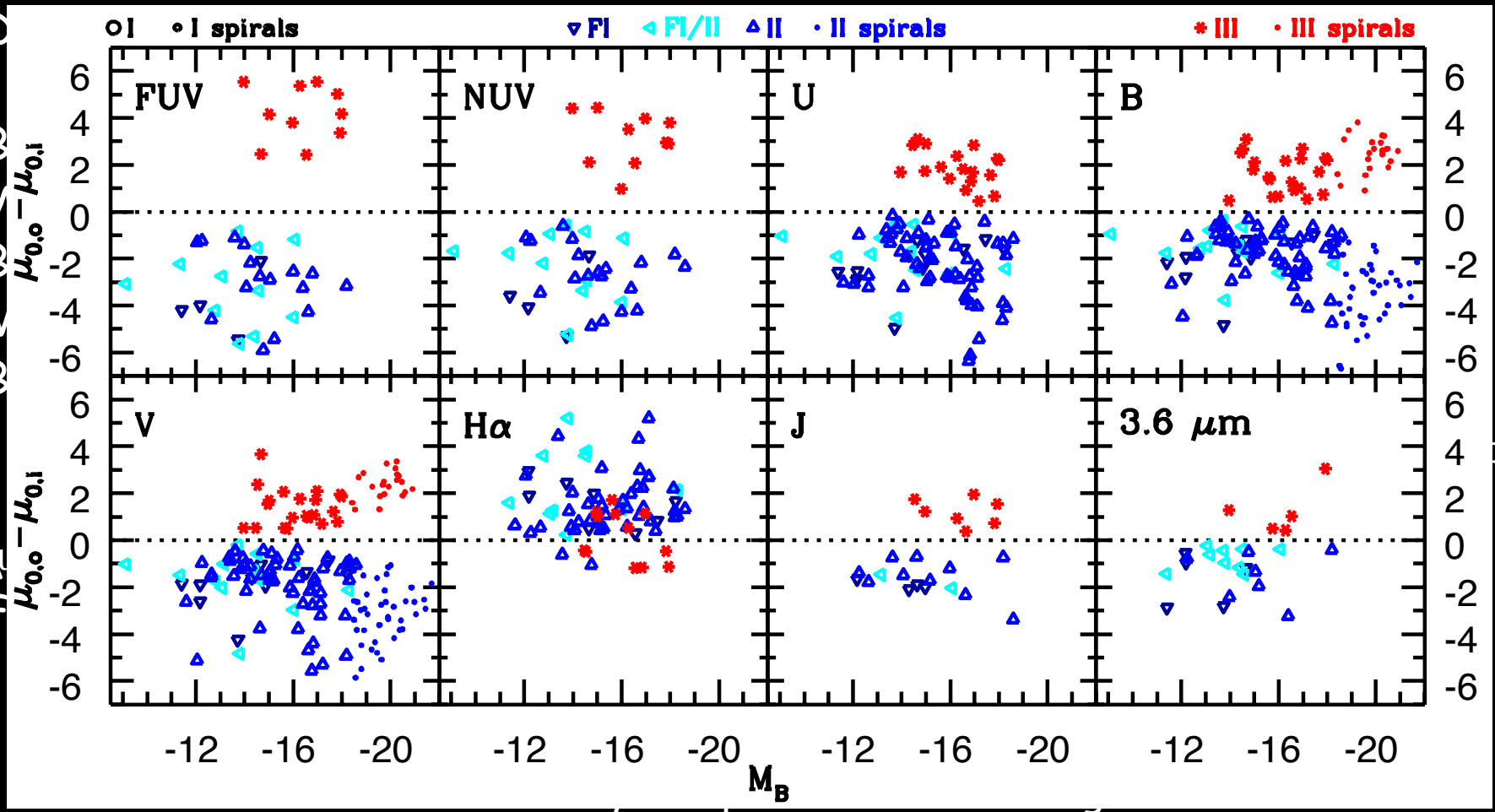


- Dwarfs extend the Profile Type trends with H
  - Early-types: more IIIs and Is; Late-types: more
- BCDs & Sms are over-represented as Types I
- We found four Type III+II profiles & 13 mul
- Bars and peculiar morphologies appear to have
- More luminous -> brighter $\mu_{0,i}$, larger $h_{R,i}$, $h_{R,o}$,
- Between IIs and IIIs:
  - Dwarfs: similar outer parameters; very different
  - Spirals: similar break parameters; very different
- μ_{br} ~ 24 mag/arcsec^2 in V for dwarfs, spirals, IIs, IIIs...
- For redder bands in dwarfs:
  - IIs: $h_{R,i}$ decreases but $h_{R,o}$ increases
  - IIIs: $h_{R,i}$ increases but $h_{R,o}$ stays the same
  - IIs & IIIs: breaks are relatively independent of wavelength

Highlights from Paper I: Profiles and Statistics

We can also look at radial colors…

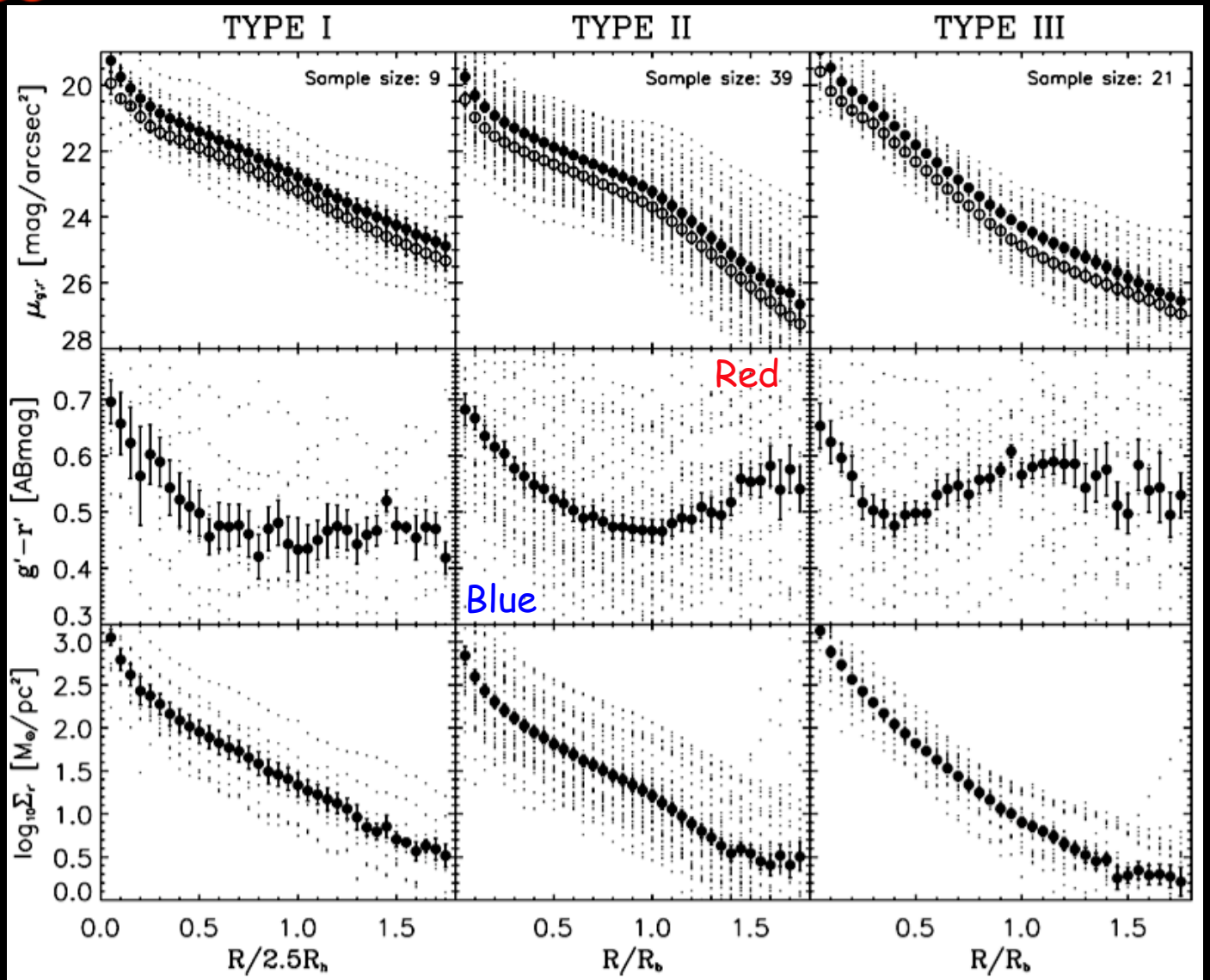




- Breaks are stronger in bluer bands and in spirals vs. dwarfs (in B&V)

Radial Color Trends in B-V

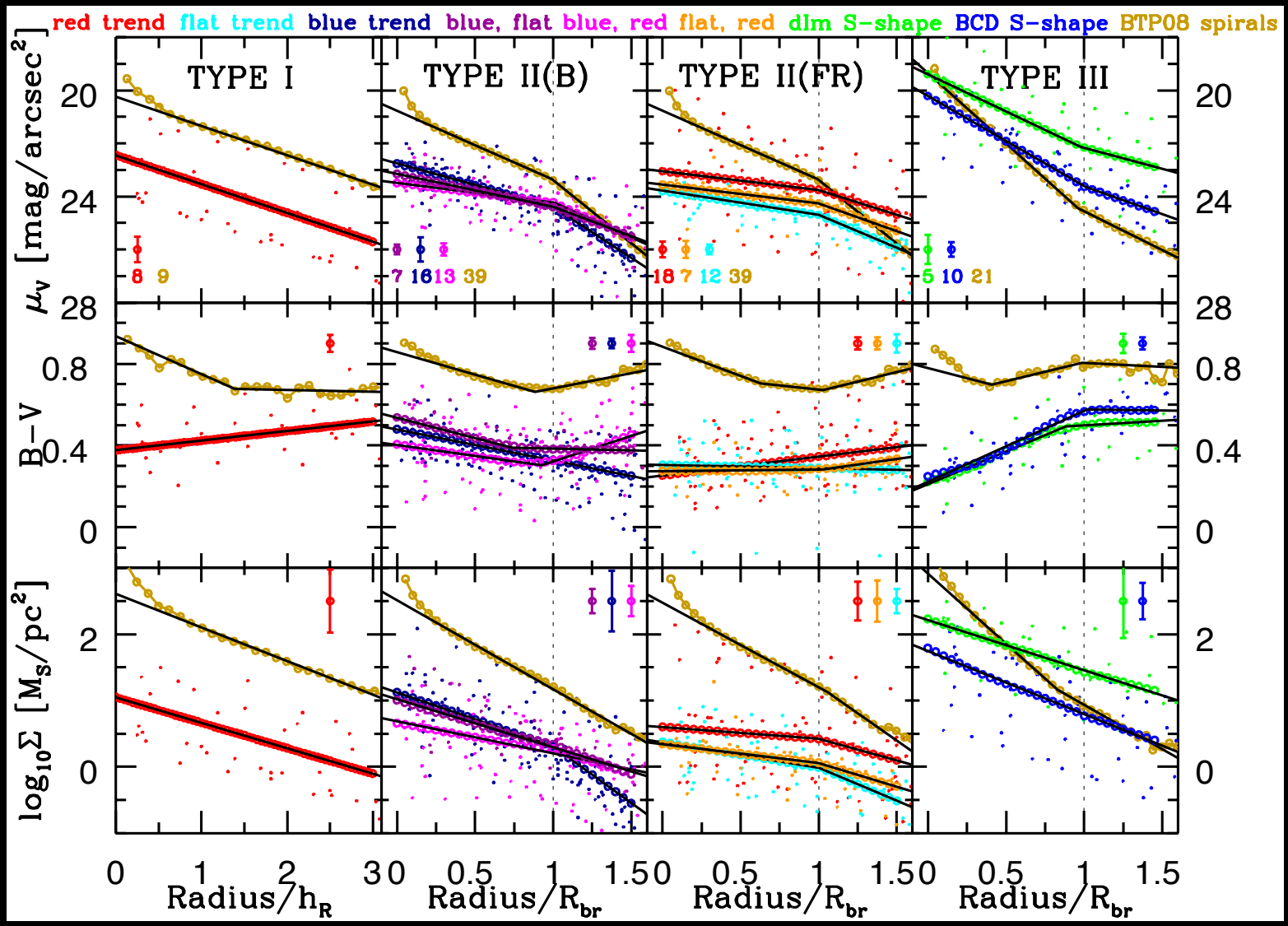
In Spirals (Bakos et al. 2008)



Radial Color Trends in B-V

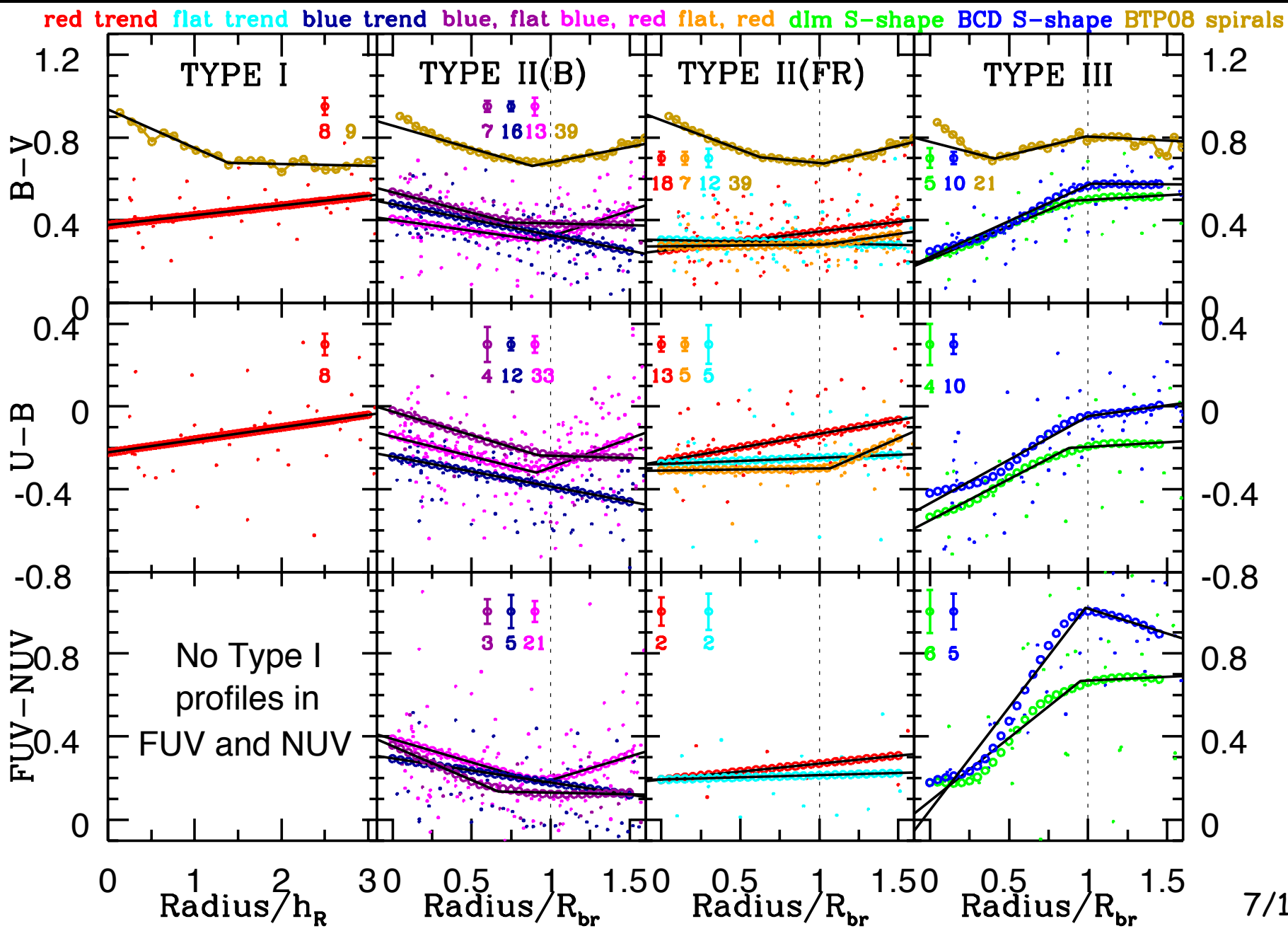
There are some outliers. *What about different colors?*

In Dwarfs (Herrmann et al., in prep, Paper II)



Same general trends, but not always the same trend for B-V, U-B, & FUV-NUV

(Herrmann et al., in prep, Paper II)



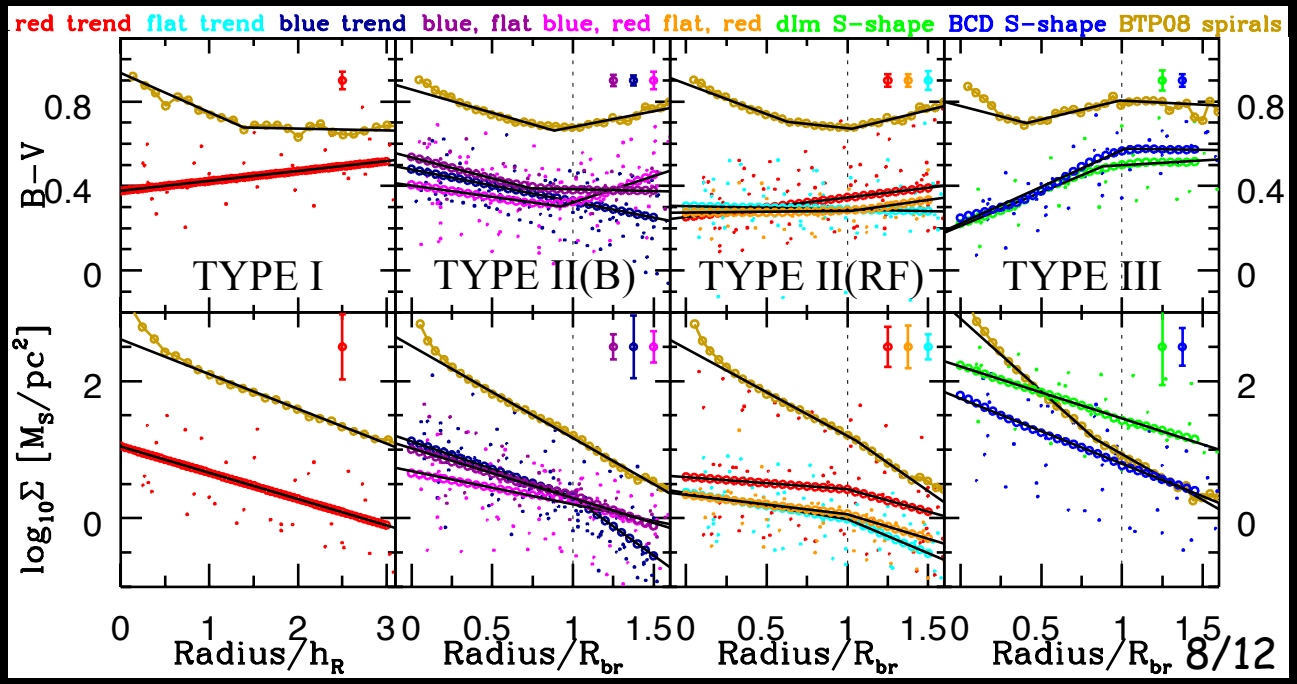
Highlights from Paper II: Color Trends and Mass Profiles

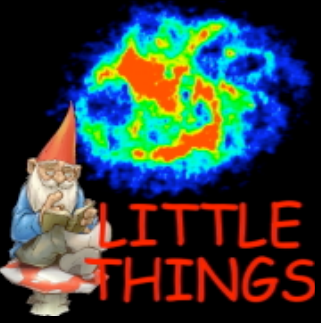
	Type I	Type II	Type III
Spirals	blue, flat	blue, red (BR = U)	blue, red, flat
Dwarfs	red	B, R, BR, F, FR, BF*	flat, red, flat (S)
Spirals	No break	Σ break reduced	Σ break remains
Dwarfs	No break	varies!^	Σ break *reduced*

*Faint ($-9 > M_B > -14$) tend to be R or BR

*Bright ($-14 > M_B > -19$) tend to be B or F

^Σ break reduced in BR & BF, but not other IIs

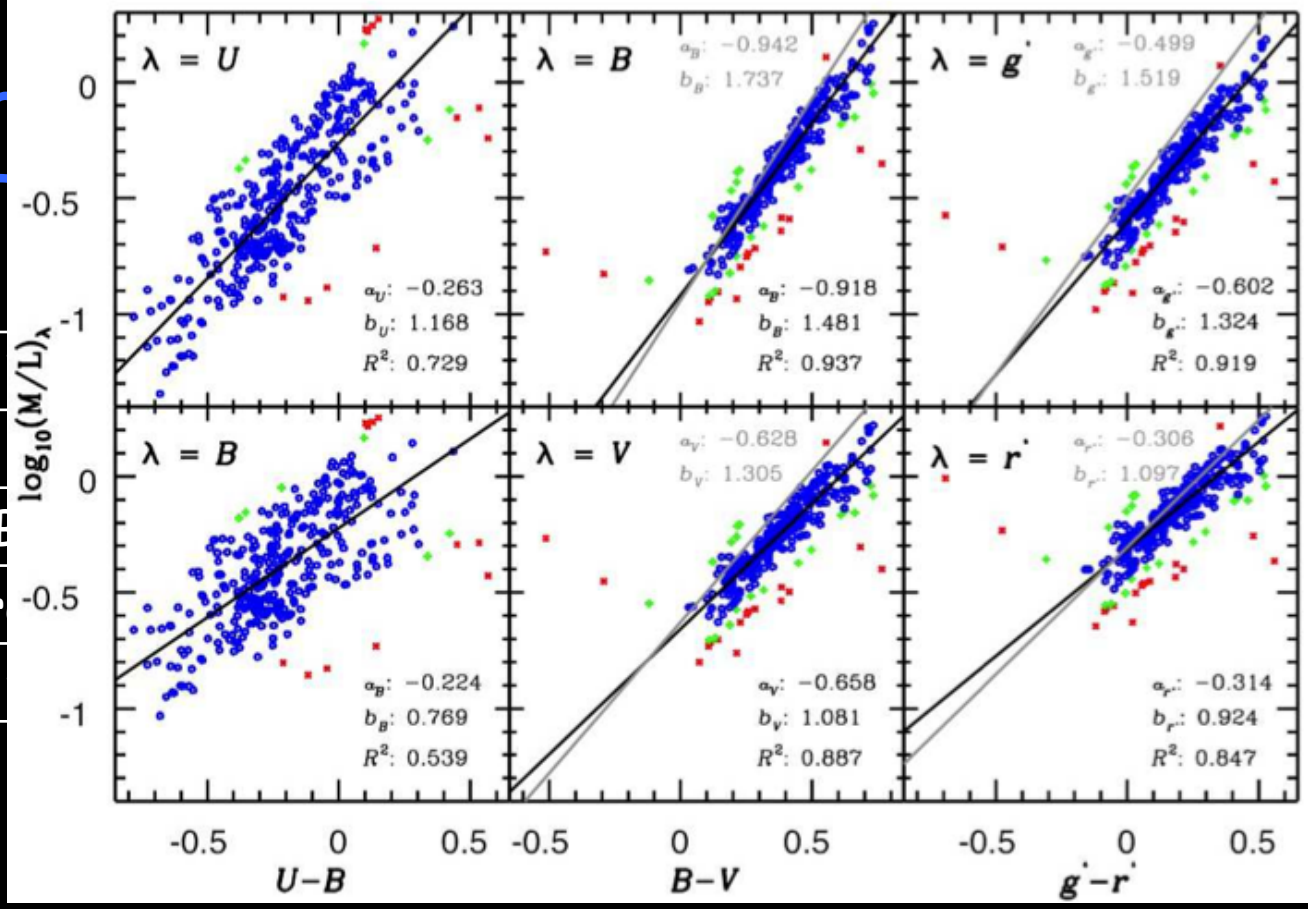




High
Color T

	Type I	
Spirals	blue, flat	blue,
Dwarfs	red	B, R, E
Spirals	No break	Σ br
Dwarfs	No break	

^Σ break reduced in BR & BF, but not other IIs



- We determined new relationships between colors and M/L for dwarfs
- Color breaks occur roughly at the surface brightness breaks
- Type III bluer than Type II inside and redder outside
- Sms/BCDs almost always have some blue/red radial color trend
- Stellar mass beyond SB break: >50% (IIR/IIFR), <40% (IIB/IIBR/III)

We have one more data set for more information…

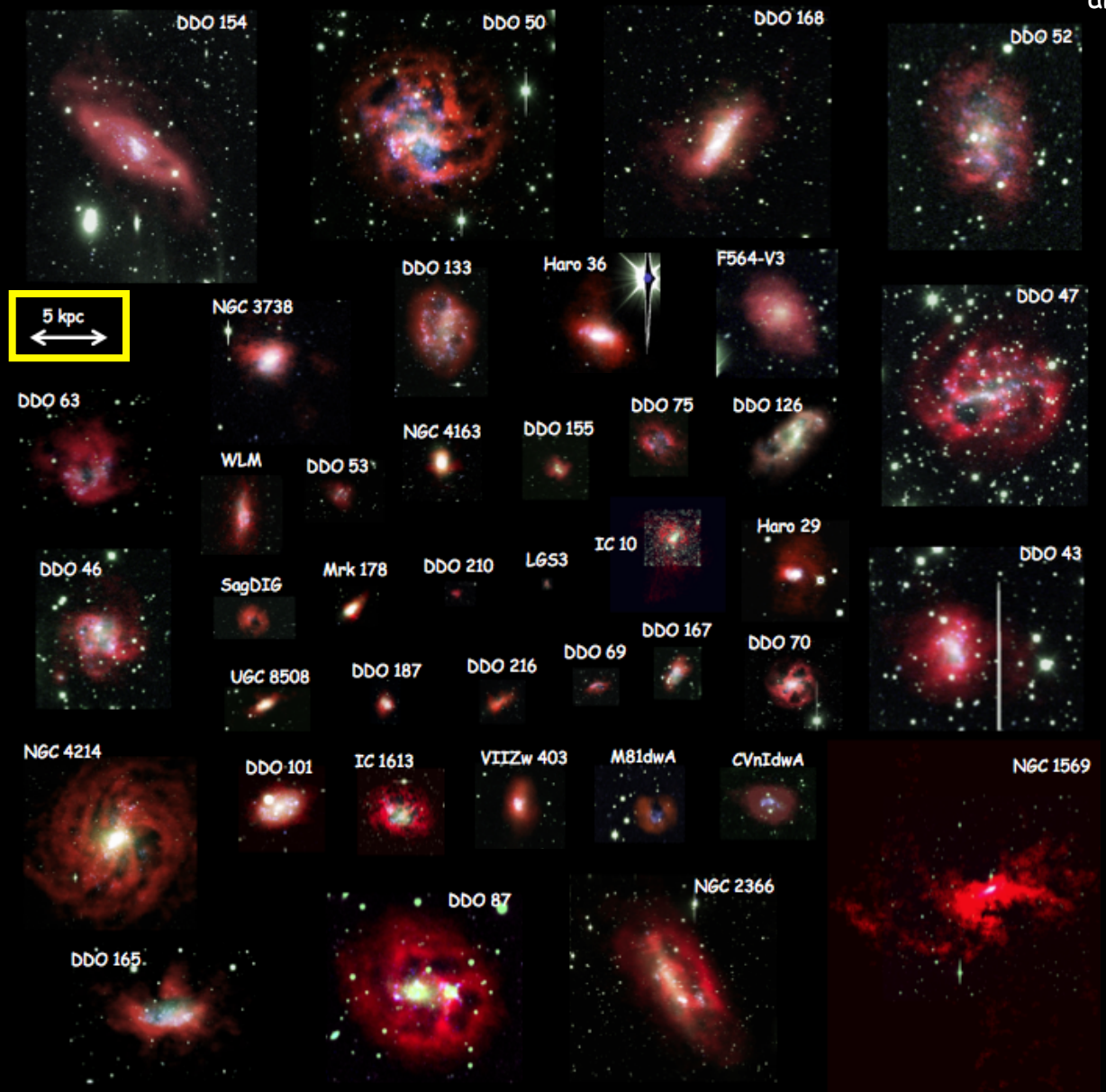
LITTLE THINGS Subsample: 36 dIms + 4 BCDs

(LITTLE THINGS team and Lauren Hill)

LITTLE THINGS

Local Irregulars That Trace Luminosity Extremes

The H (hydrogen) I (neutral) Nearby Galaxy Survey

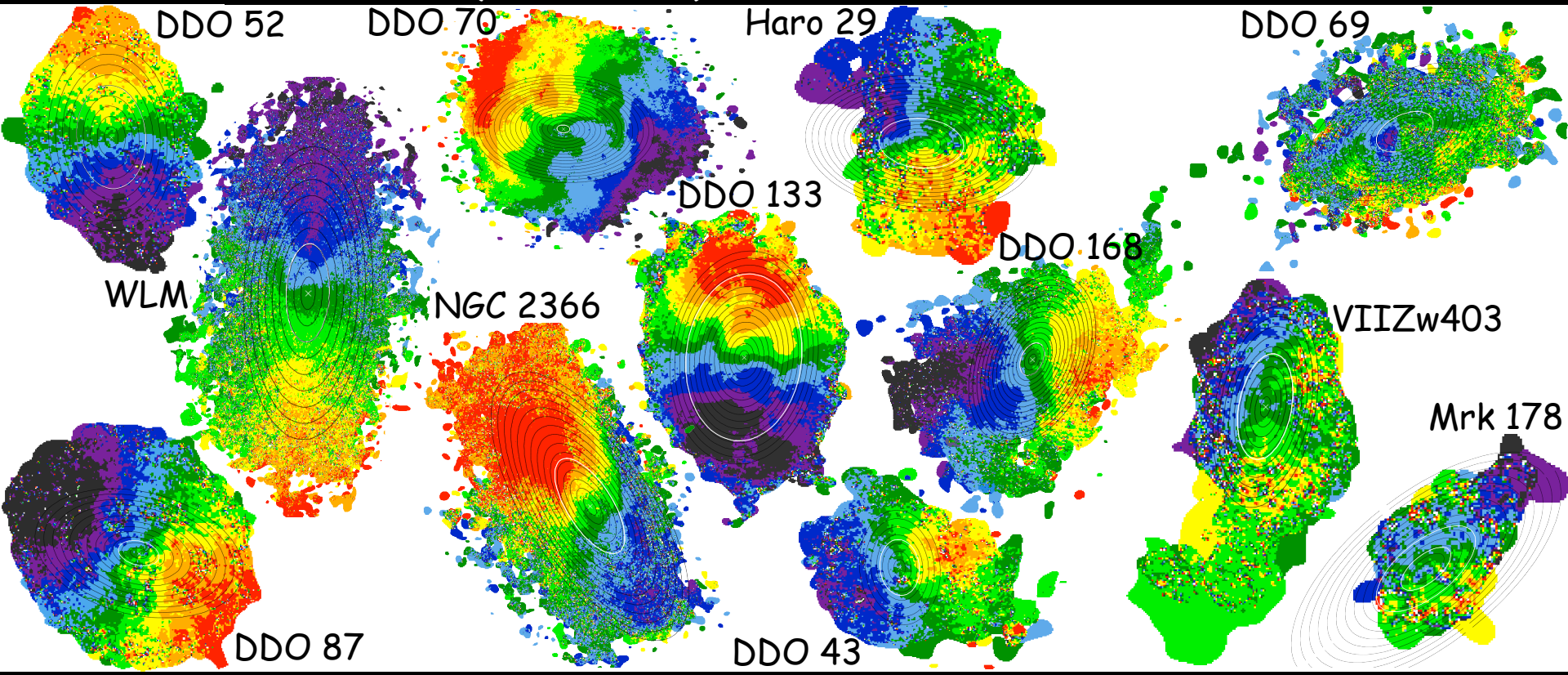


HI (red) FUV (blue) V (green)

Breaks & LT HI kinematics

1) Are the optical & kinematic axes aligned?

Yes (15/40) | Yes (7/40) (w/ structure) | No (7/40) | Rotation? (11/40)

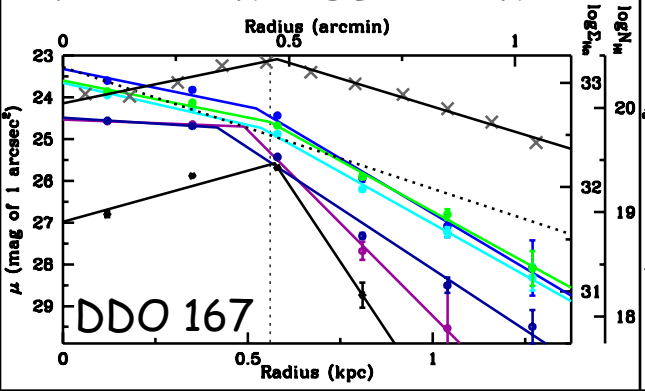


2) Where is the break wrt the rotation curve turnover?

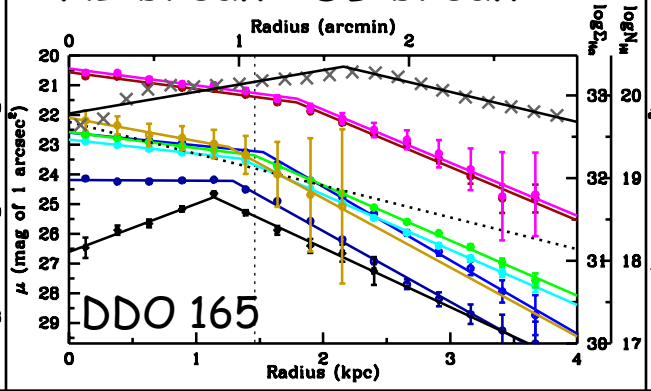
Breaks & LT HI density profiles

21/40 HI profiles have a FI shape (in the SB radial area):

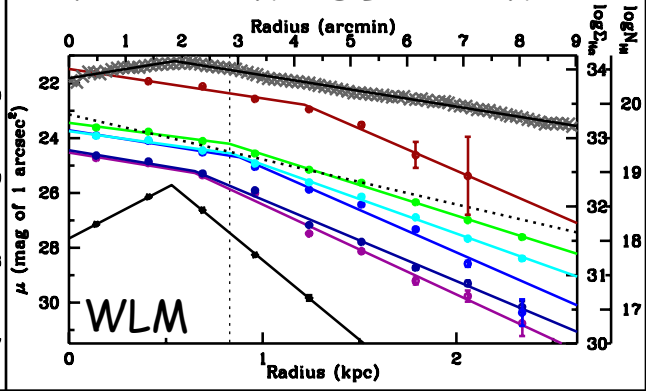
HI break ≈ SB break: 5



HI break > SB break: 12

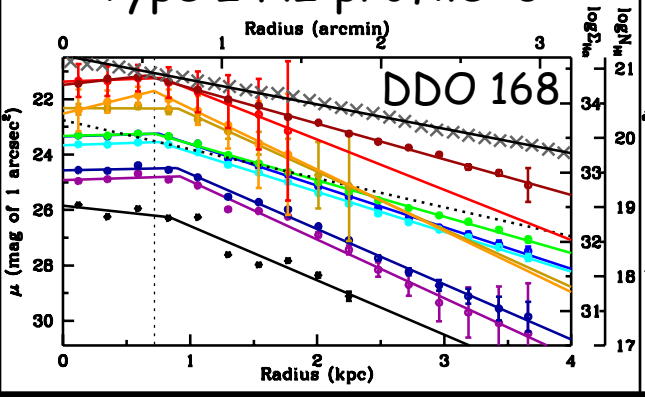


HI break < SB break: 4

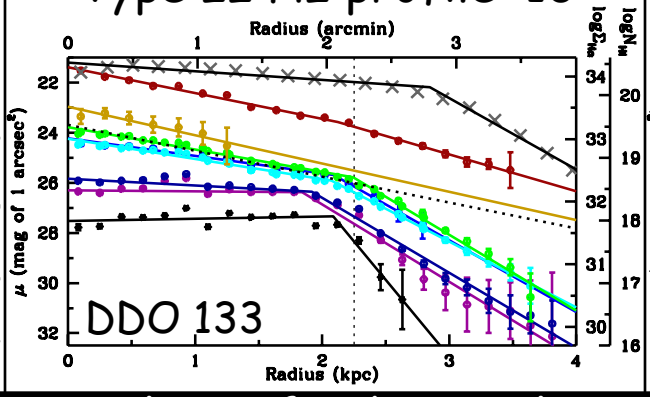


19/40 HI profiles have a I, II, or III shape: (Herrmann et al., in prep, Paper III)

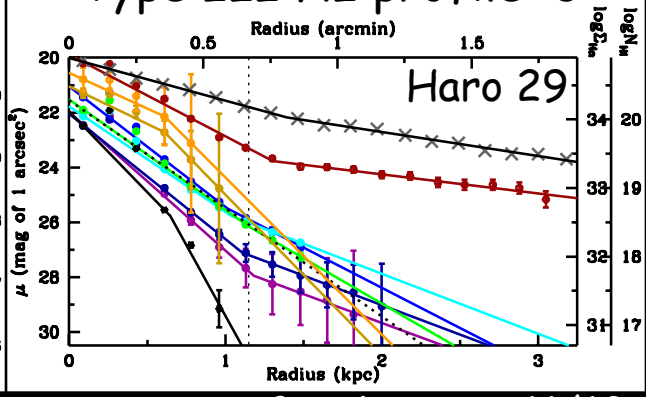
Type I HI profile: 6



Type II HI profile: 10

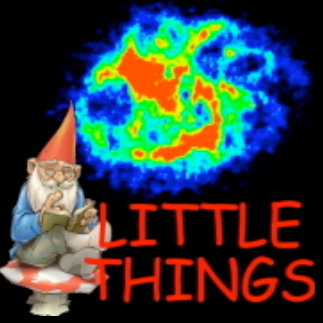


Type III HI profile: 3



4 similar, 5 farther, 1 closer

3 farther



Some Take Away Points

From Paper I (Profiles and Statistics, Herrmann et al 2013):

- Dwarfs extend Profile Type trends w/ Hubble type (early: IIIs, late: IIs)
- Many trends in SB fit parameters: M_B = -9 dwarfs to M_B = -21 spirals
- Some parameters constant over that range (μ_{br} ~ 24 mag/arcsec^2 in V)
- Interesting λ trends in dwarfs; multi-λ studies needed for spirals!
- Overall: Inner *depletion* trend in IIs vs. inner *accretion* trend in IIIs?

From Paper II (Color Trends and Mass Profiles, Herrmann et al in prep):

- Type III dwarf color radial profiles fairly similar to those of spirals
- Type II dwarfs: come in many more flavors than the BR "U" of spirals!
- We determined new relationships between colors and M/L for dwarfs
- Σ break: reduced in Spiral IIs, remains in Spiral IIIs
  reduced/remains in Dwarf IIs, reduced in Dwarf IIIs

Next: What do HI kinematics & density tell us about SB profile breaks?

NRAO, NSF, LT team, friends, family:
Thank you!!!! (and you, too, for listening!)

Questions?