Investigating the Environmental Dependencies of Gas-Fuelling in GAMA galaxies

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MAX-PLANCK-INSTITUT FÜR KERNPHYSIK

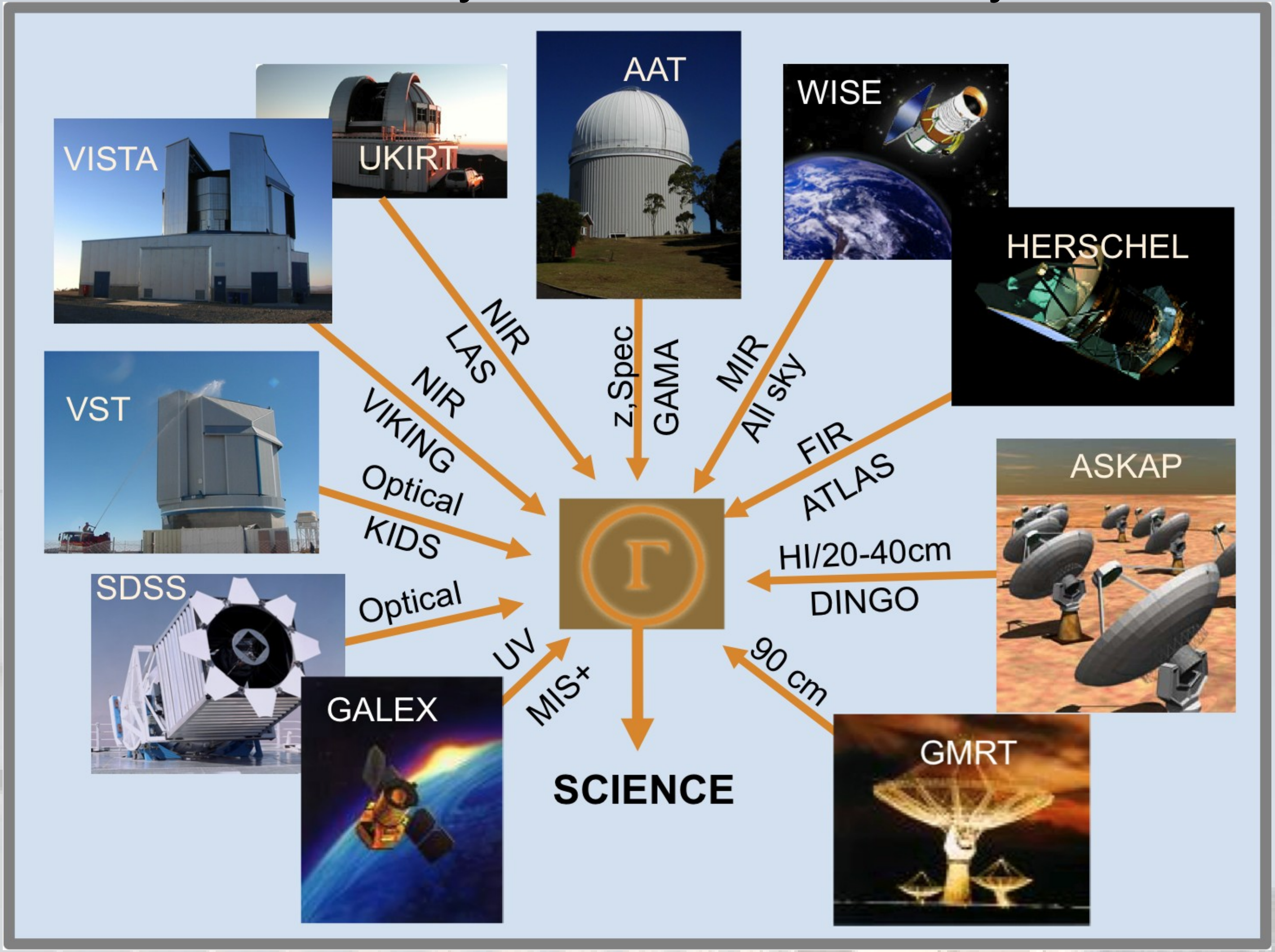
Outline

PART I : The Dust Opacity – Stellar Mass Surface Density Relationship for Spiral Galaxies

PART II : Preliminary Results on Environmental Dependencies of Gas-Fuelling

Dust Opacity – Stellar Mass Surface Density

Galaxy And Mass Assembly



IAU Symposium 284
07.09.2011

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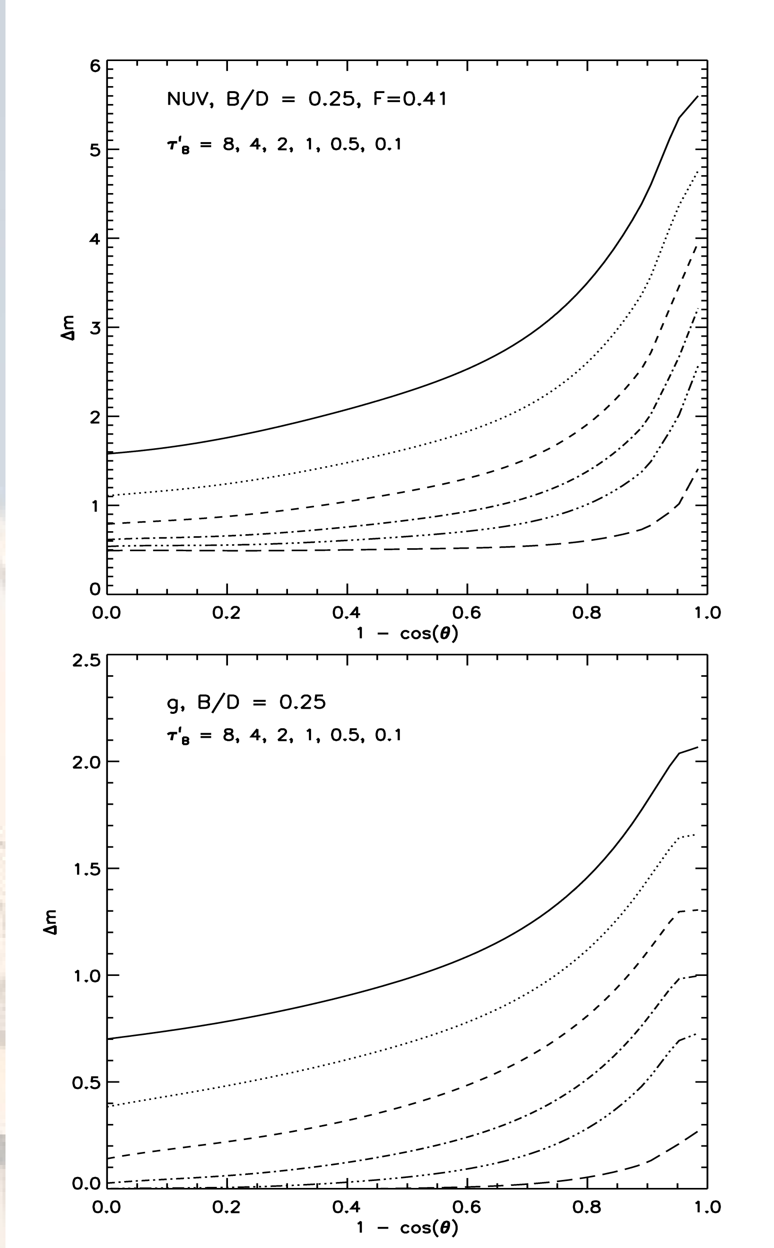
Dust Opacity – Stellar Mass Surface Density

- Use RT model of late-type rotationally supported systems to determine attenuation due to dust (Popescu et al., 2011)

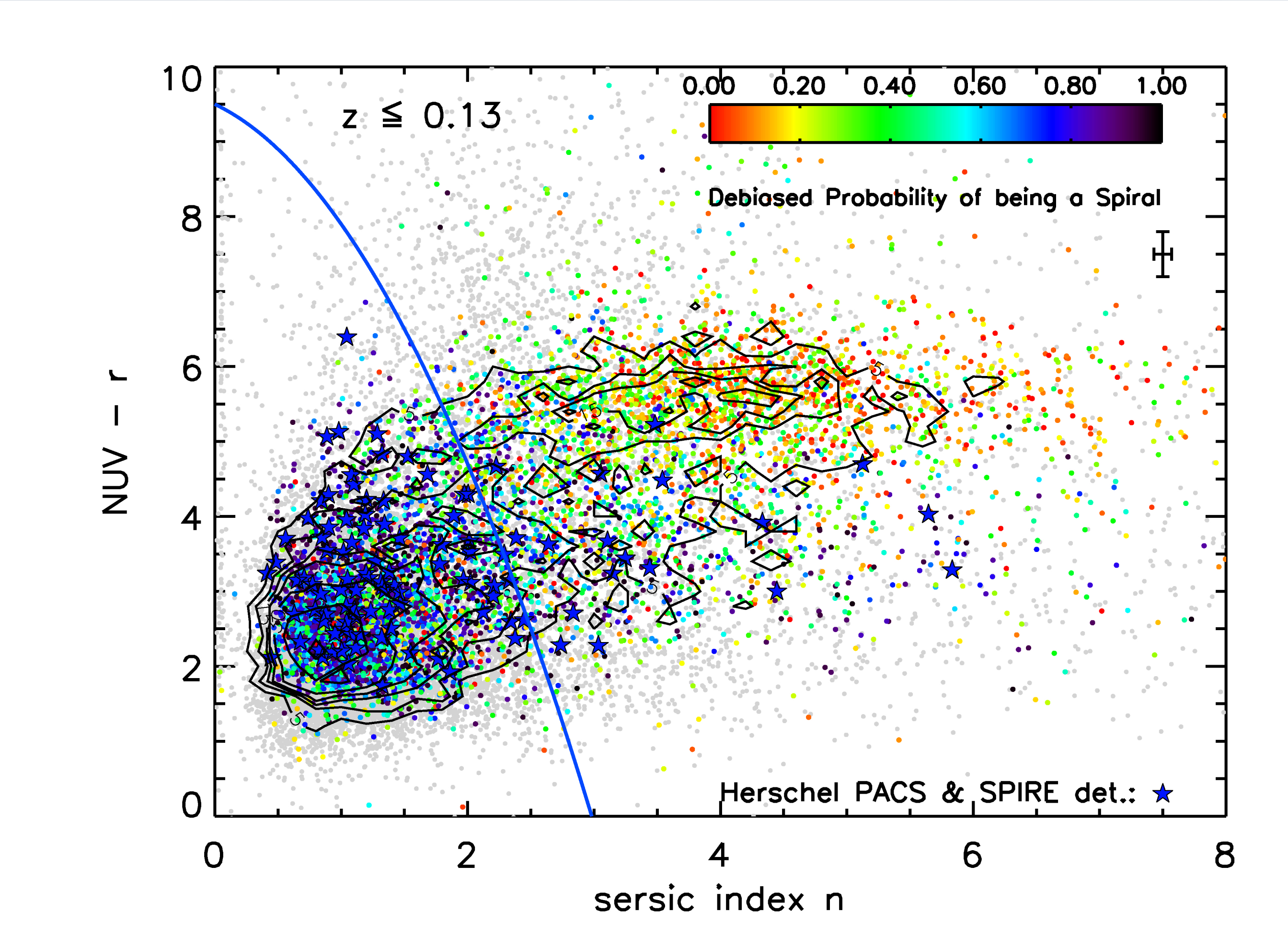
- Necessary inputs:
  - τ^{f}_{B} ; Face-on central dust optical depth in B band
  - Inclination
  - B/D ratio

(See poster E. Andrae)



Dust Opacity – Stellar Mass Surface Density

- Select Spiral galaxies
- GAMA single Sersic photometry and morphological fits; Kelvin et al., in prep.
- Define separator calibrated on Galaxy ZOO DR1 data



Dust Opacity – Stellar Mass Surface Density

Dust optical depth τ :

$$\tau_B^f = \frac{const * M_{dust}}{(\pi r^2)}$$

- Derive M_{dust} from grey-body fit of HERSCHEL/H-ATLAS FIR data (PACS & SPIRE in SDP field)
- Use well-kown source (NGC891) as geometrical template to derive value of const
- Estimate r from single-Sersic morphological fit

Dust Opacity – Stellar Mass Surface Density

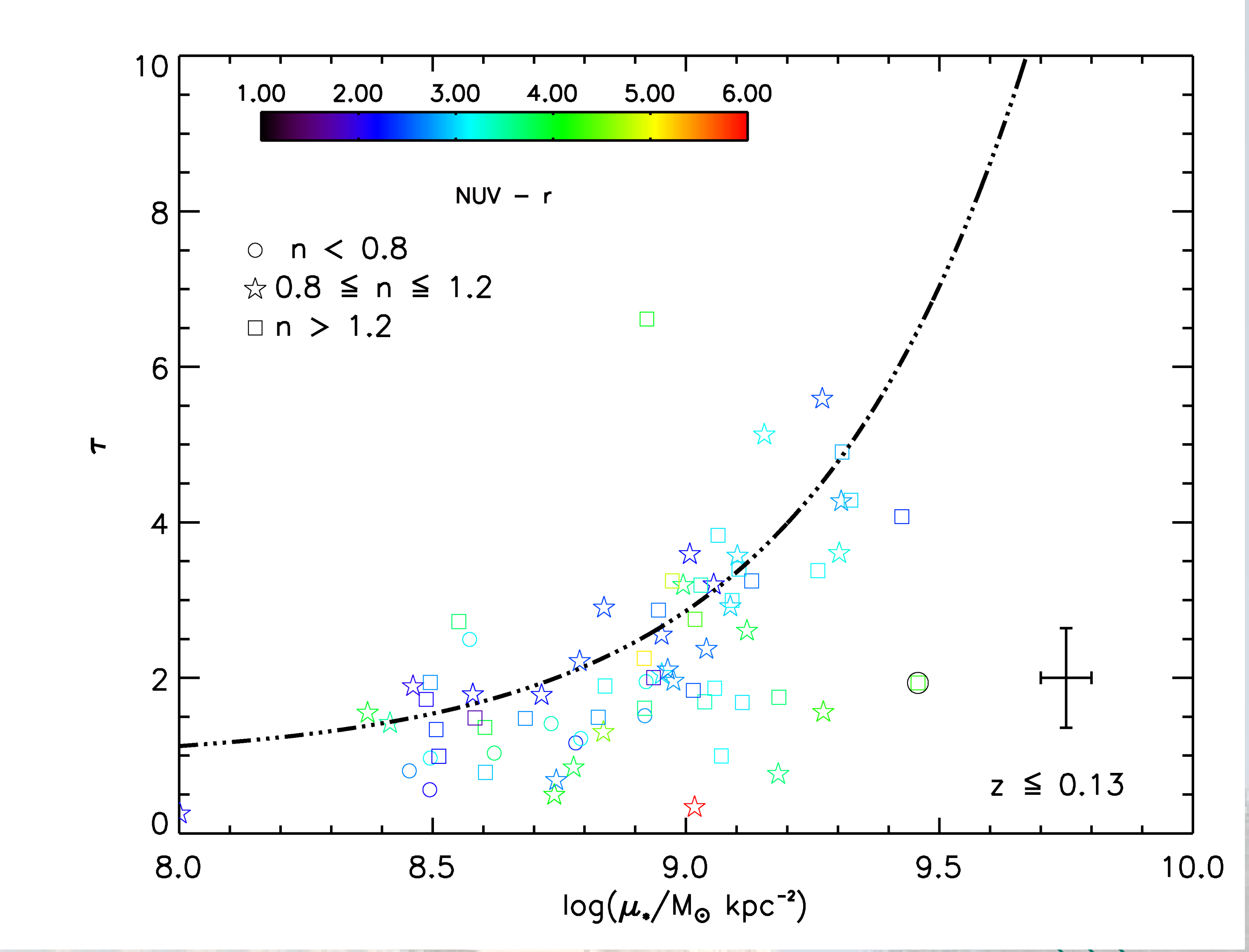
- Comparison with available, overlapping Bulge + Disk fits (Simard et al., 2011) shows that inclination, disk scale length r, and B/D ratio can be accurately estimated using the available single Sersic parameters for the sample of spiral galaxies

- 115 reliably matched simultaneous 3-σ PACS & SPIRE detections of ca. 2000 GAMA sources in SDP field out to z ≤ 0.13

→ bootstrap onto optical properties

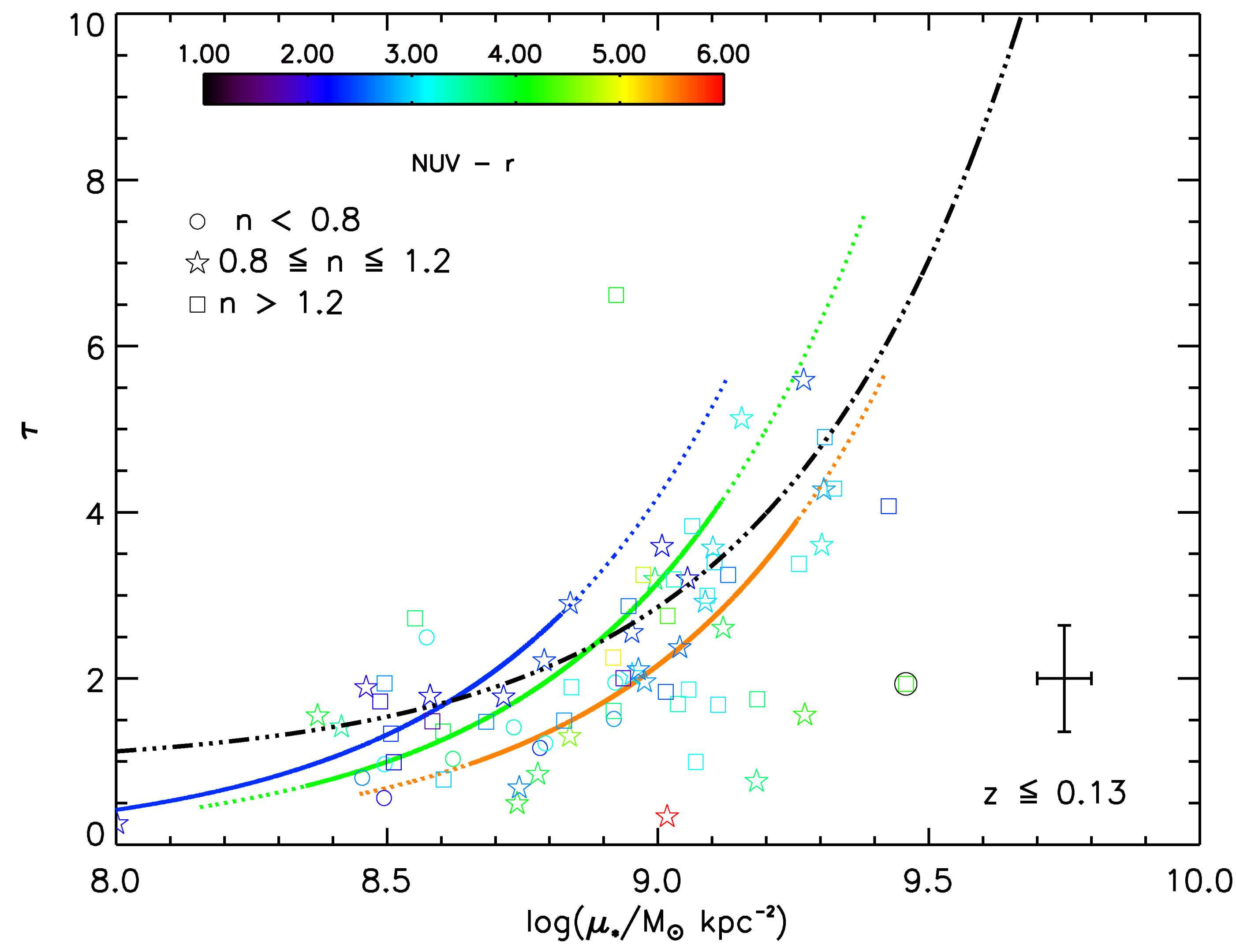
Dust Opacity – Stellar Mass Surface Density

- GAMA stellar masses, Taylor et al., 2011
- Linear correlation between τ^f_B and stellar mass surface density μ_*, r = 0.57

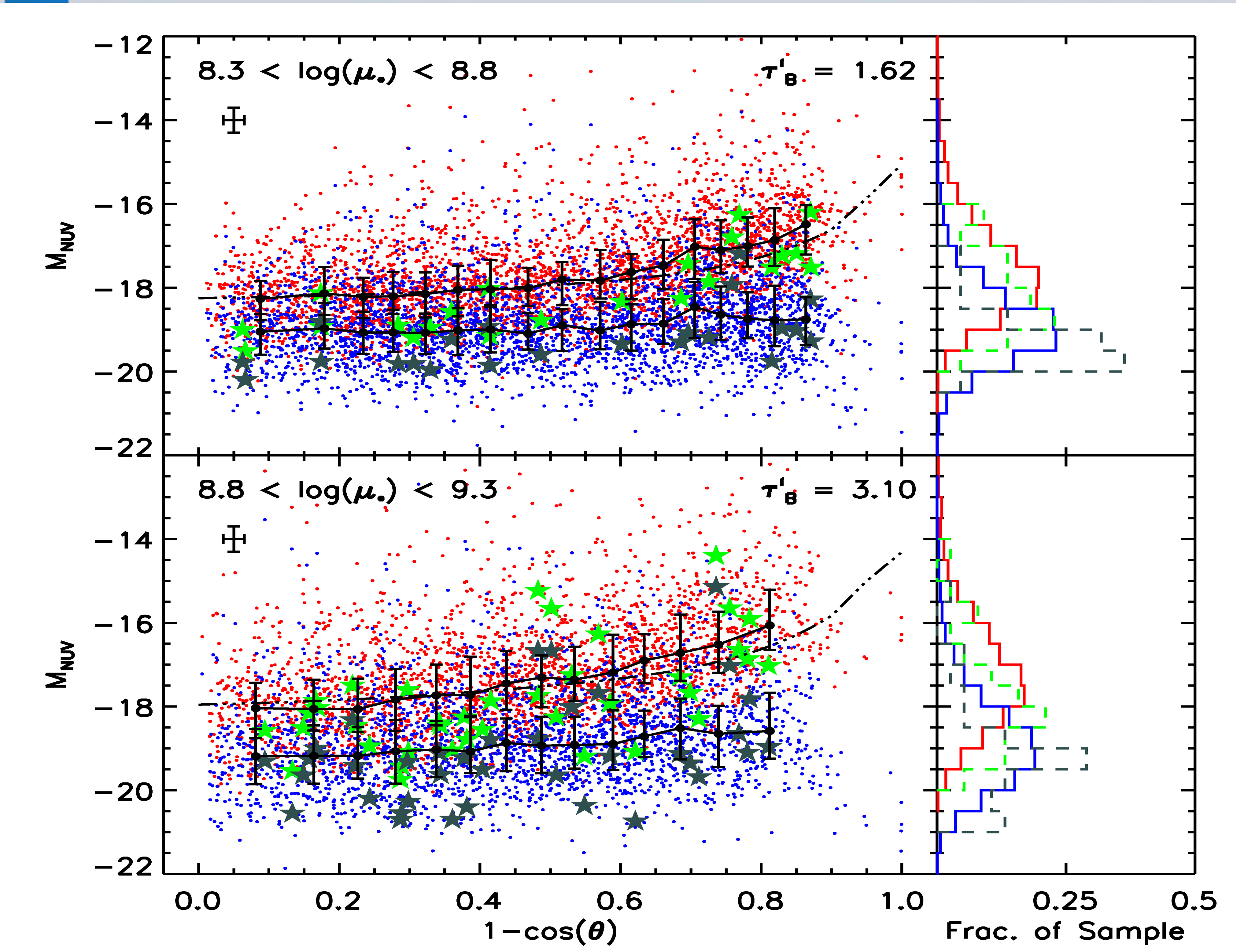


Dust Opacity – Stellar Mass Surface Density

- GAMA stellar masses, Taylor et al., 2011
- Linear correlation between τ^f_B and stellar mass surface density μ_*, r = 0.57
- Qualitatively fits expectations from simple model based on Edmunds 2001 with in- and outflows, using M_{gas}/M_* vs. M_* from Peeples & Shankar, 2011



Dust Opacity – Stellar Mass Surface Density



GAMA

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Summary: Dust Opacity – Stellar Mass Surface Density

- Identification of a potential method to statistically correct for inclination dependent attenuation in rotationally supported galaxies using only (UV-)optical photometric and morphological information(→ μ_*)

- Qualitative agreement with results from simple model of evolution of dust mass in galaxies

- Test on sample of late-type galaxies in appropriate range without HERSCHEL FIR data demonstrates applicability

Additional HERSCHEL & WISE data + Full RT modelling expected to improve estimates of τ and extend range in μ_*

PART II: Preliminary Results on Environmental Dependencies of Gas-Fuelling

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Gas-Fuelling & Environment

Supply of gas for SF to galaxies by two main processes:

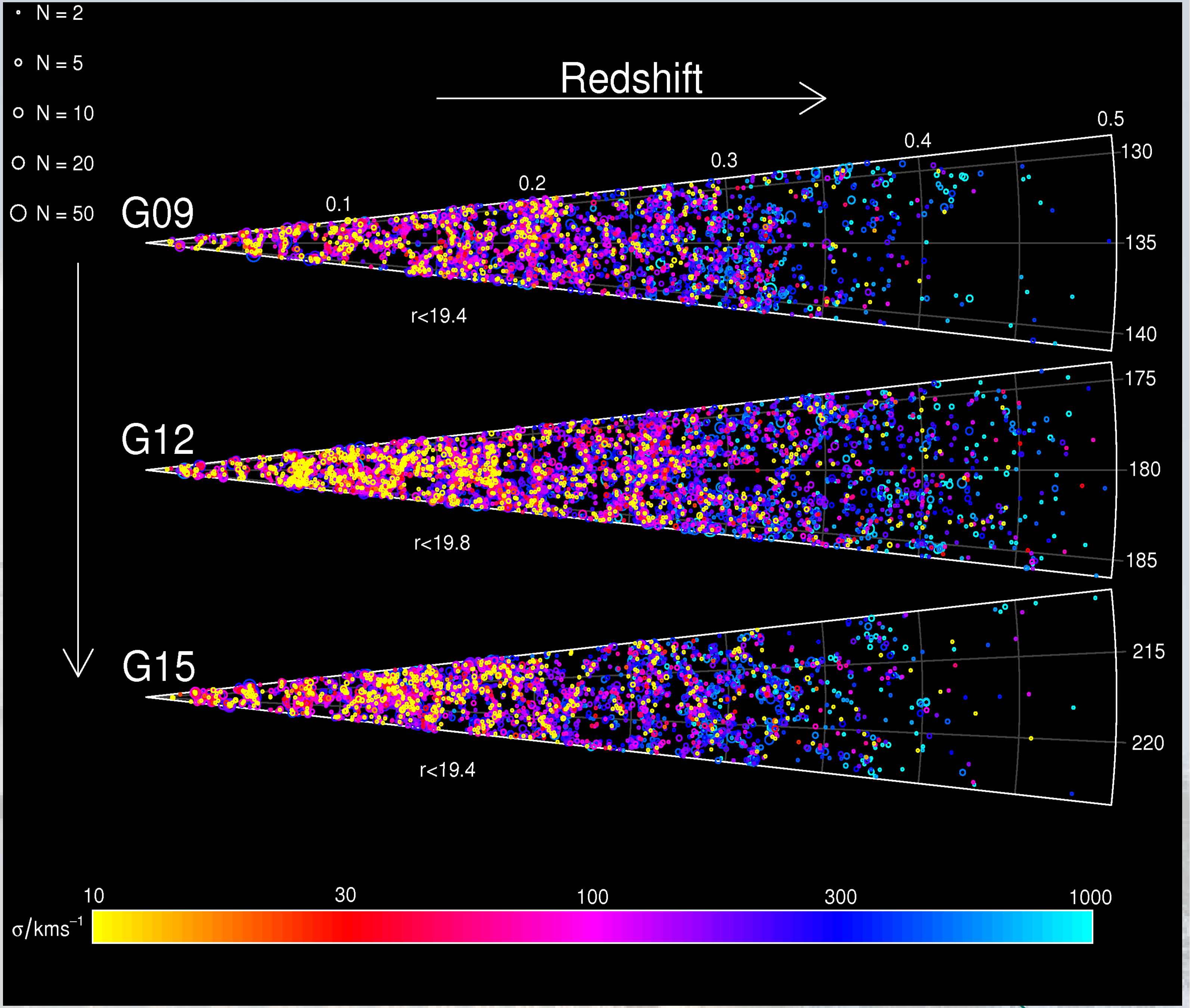
- Mergers of gas-bearing galaxies
- Direct accretion from IGM

Accretion predicted to be function of environment:

- Decline with DMH; virial heating
- Baryonic feedback; galactic winds (SF, AGN)

Empirically unconstrained for mass scales of galaxy groups

Gas-Fuelling & Environment



Spectroscopic FoF groups with unprecedented range to low masses

G[3]Cv1:
Gama Galaxy Group Catalogue (Robotham et al., 2011)

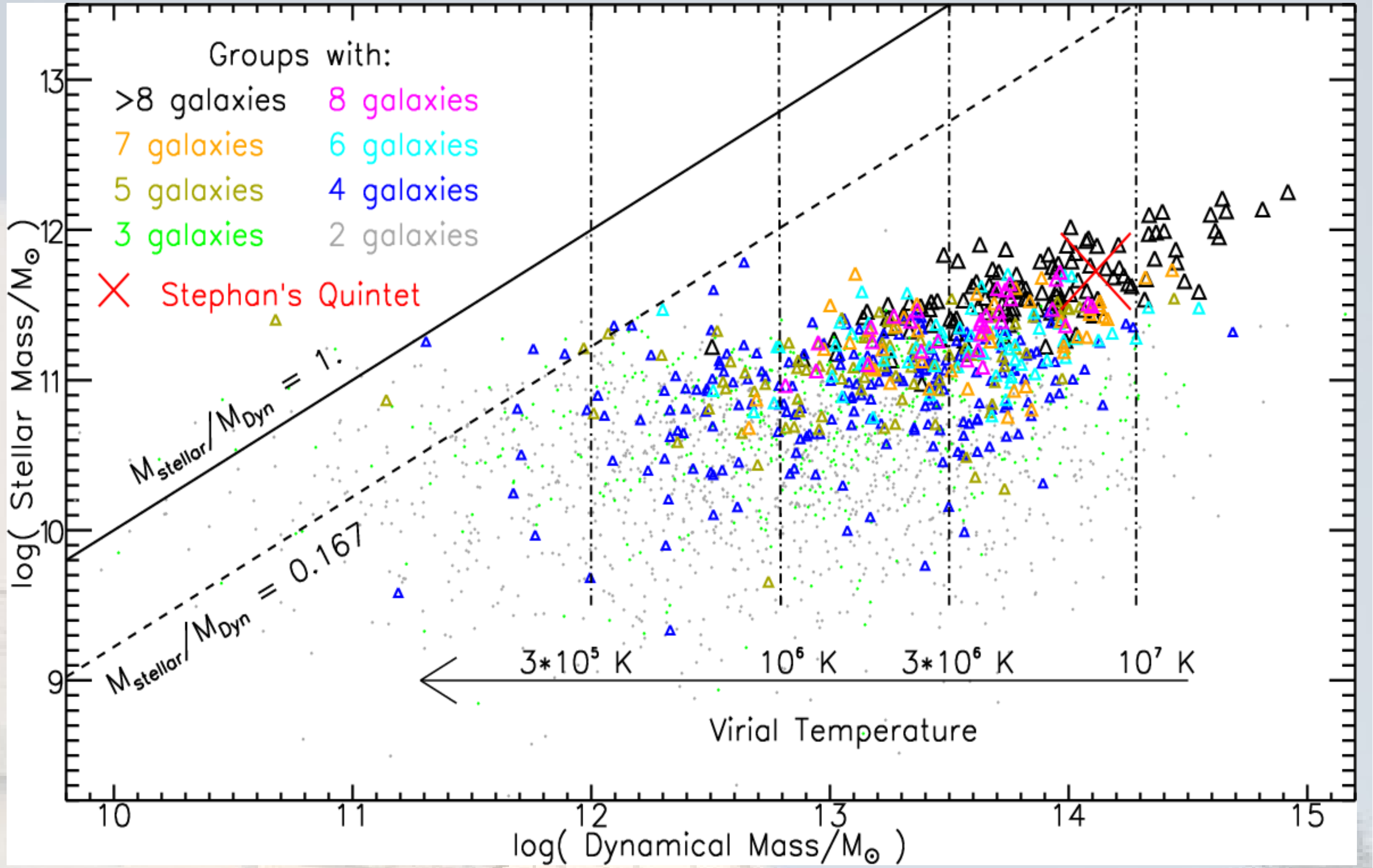
Robotham et al., 2011

Gas-Fuelling & Environment

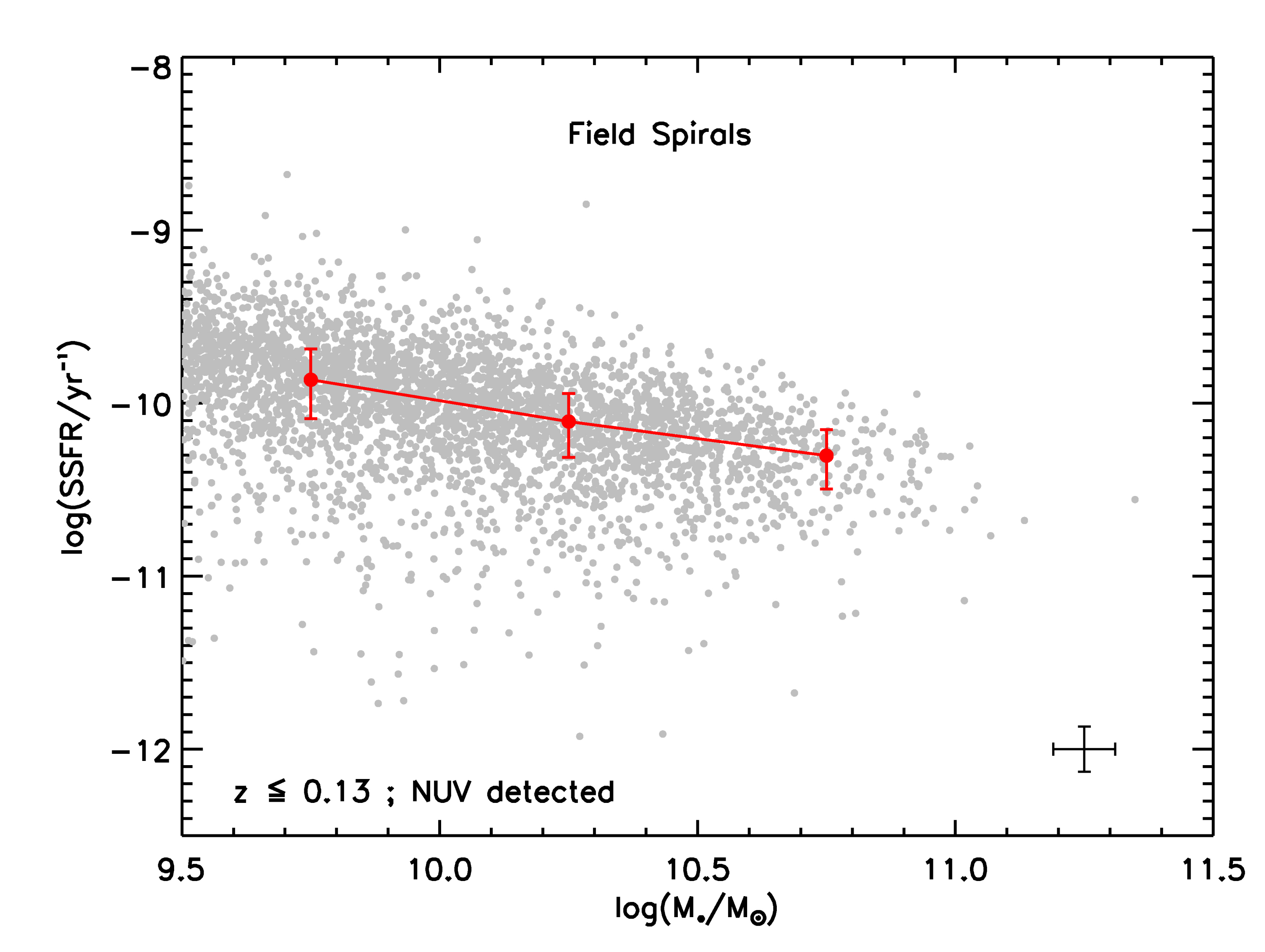
- Assume balance between SF and replenishment from IGM for unperturbed intermediate mass late-type galaxies

Use NUV SFR as tracer of gas-fuelling

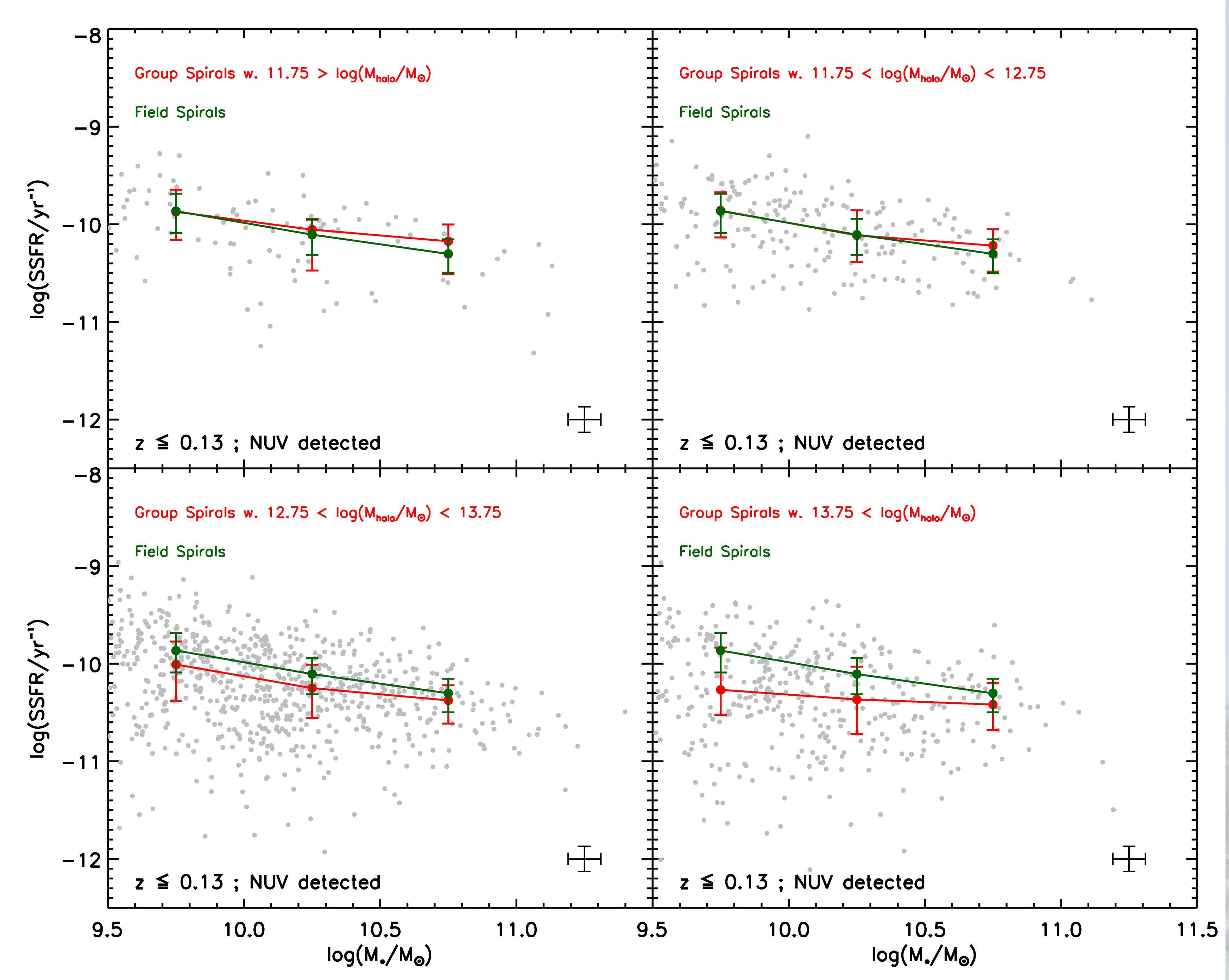
- Use local sample (z ≤ 0.13) to minimize evolutionary effects



Gas-Fuelling & Environment



Gas-Fuelling & Environment



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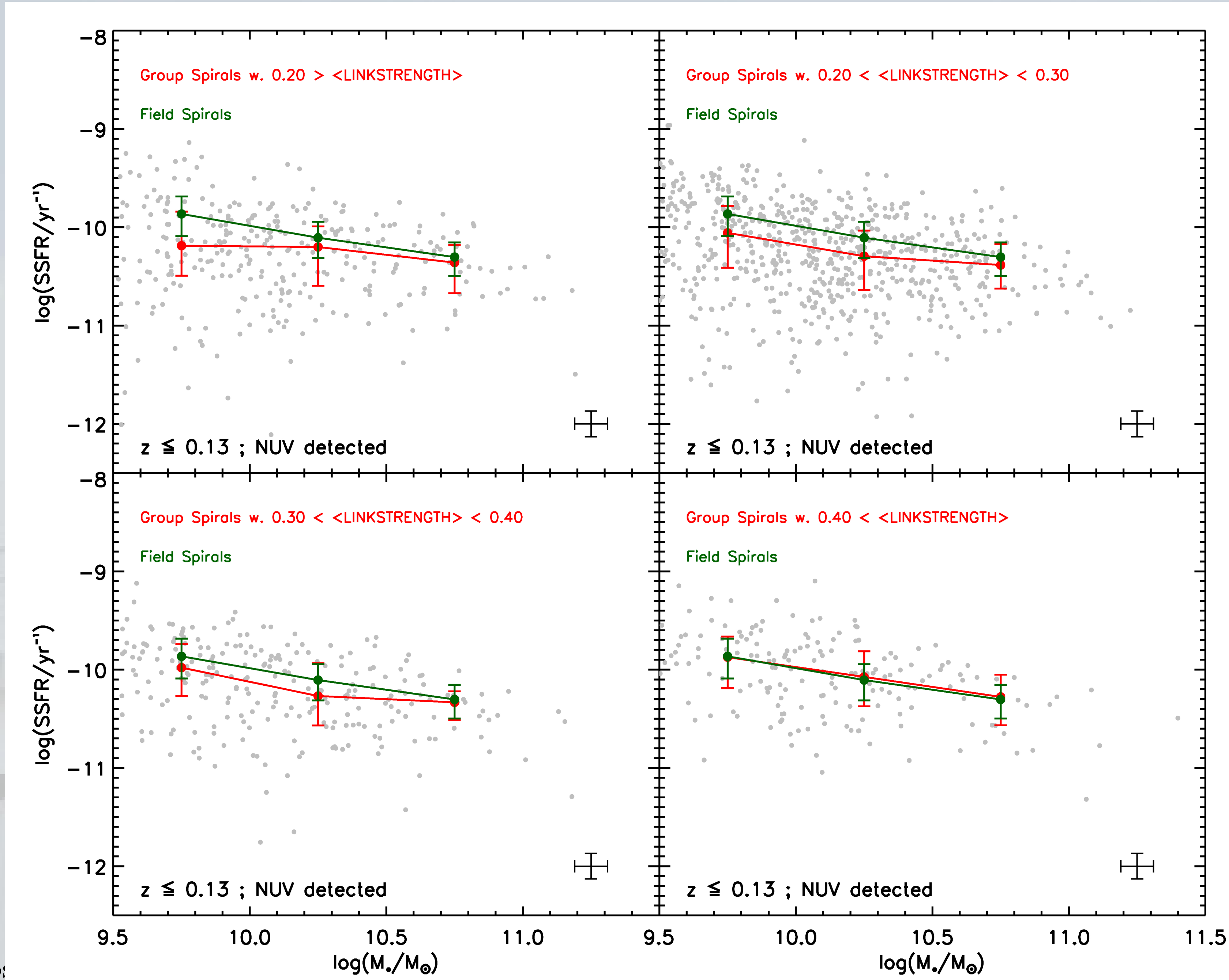
Gas-Fuelling & Environment



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SSFR in Groups

- Dynamical Mass
  - Markedly lower SSFR for $M_* < 10^{10.25} M_\odot$ galaxies in $M_{halo} > 10^{13.75} M_\odot$ halos w.r.t. field sample
  - Increasing similarity to field sample for larger galaxy masses in all halos
- Compactness
  - Decrease in SSFR for low mass galaxies w.r.t. field sample in more compact groups
  - SSFR of higher mass galaxies less/not affected by compactness

Summary & Outlook

Summary:

- Identification of potential method to statistically correct for inclination dependent attenuation in rotationally supported late-type galaxies using only (UV-)optical photometric and morphological information

- Preliminary application to group spirals shows a decline in SSFR with halo mass and group compactness for $M_* < 10^{10.25} M_\odot$ galaxies, in agreement with previous results.

- SSFR of spiral galaxies with $M_* > 10^{10.5} M_\odot$ shows little dependence on environment

Outlook:

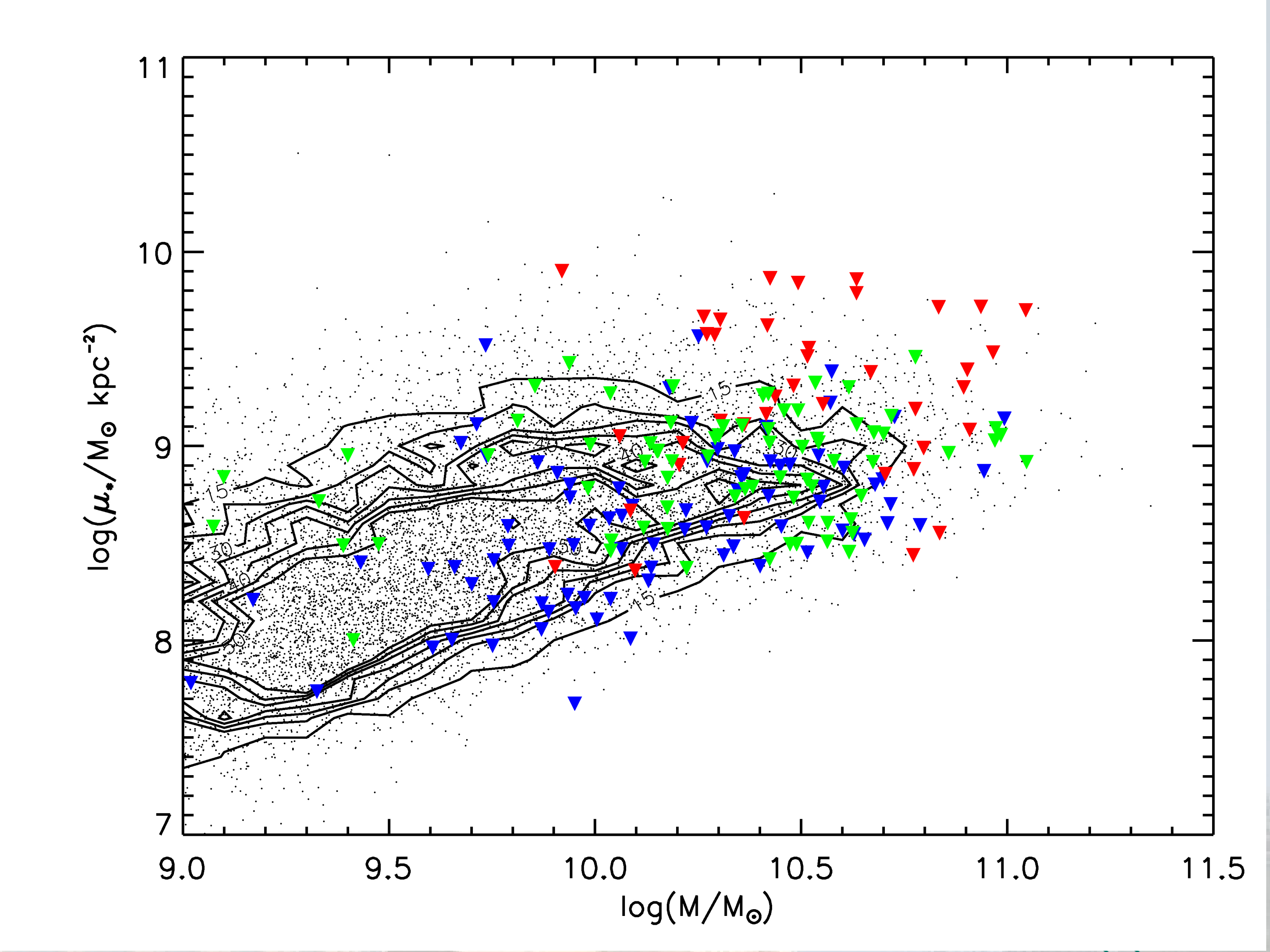
- Check and extend $\tau - \mu_*$ relation using more FIR data and fully self-consistent RT modelling as available

- Use single narrow stellar mass bin as standard probe for gas-fuelling and attempt a multi-variate analysis using halo mass and group concentration

Extra Slides

Applicability

- Range in μ_* representative of population in M_* for $M_* > 10^{9.5}$ $M_\odot$
- Corresponds to mass of classical spirals



SFR as Tracer of Gas-Fuelling

- Assume to first order a balance between SF and gas replenishment from IGM (for higher mass, unperturbed galaxies)

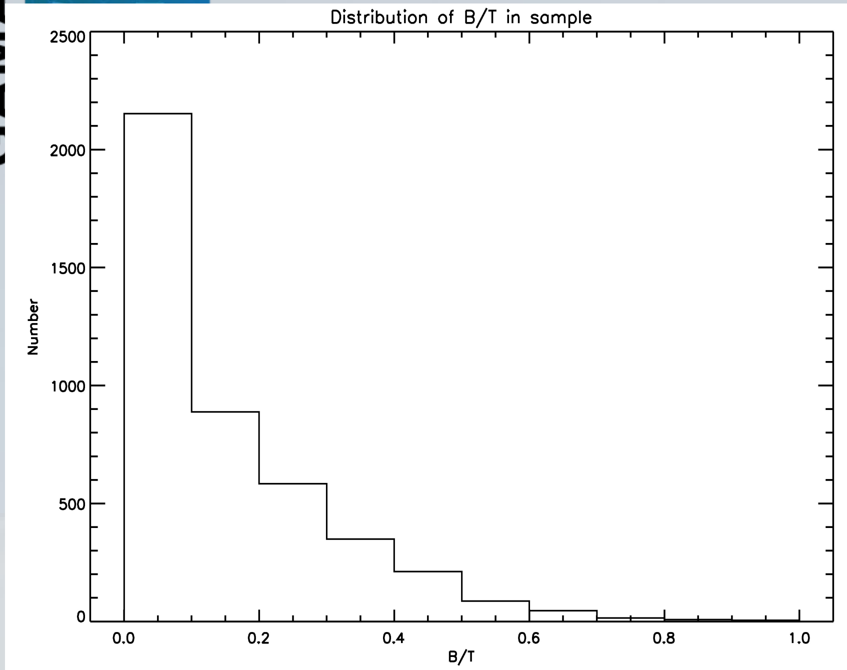
→ SFR of normal,non-bursting, late-type galaxies as tracer of gas-fuelling

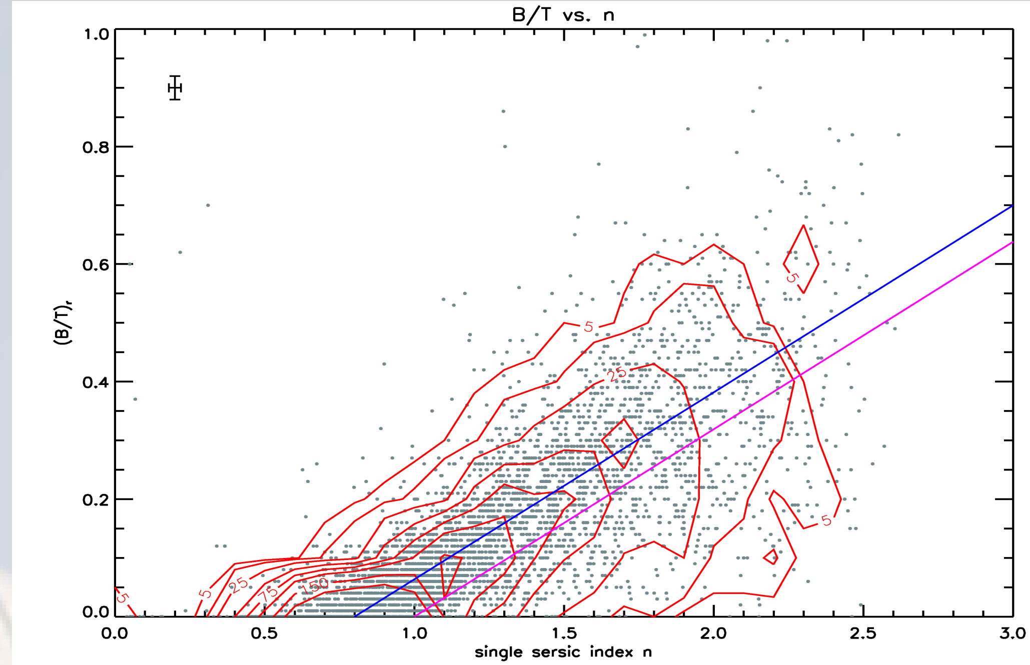
- Most group members will have resided inside the accretion shock for a large fraction of the group age.

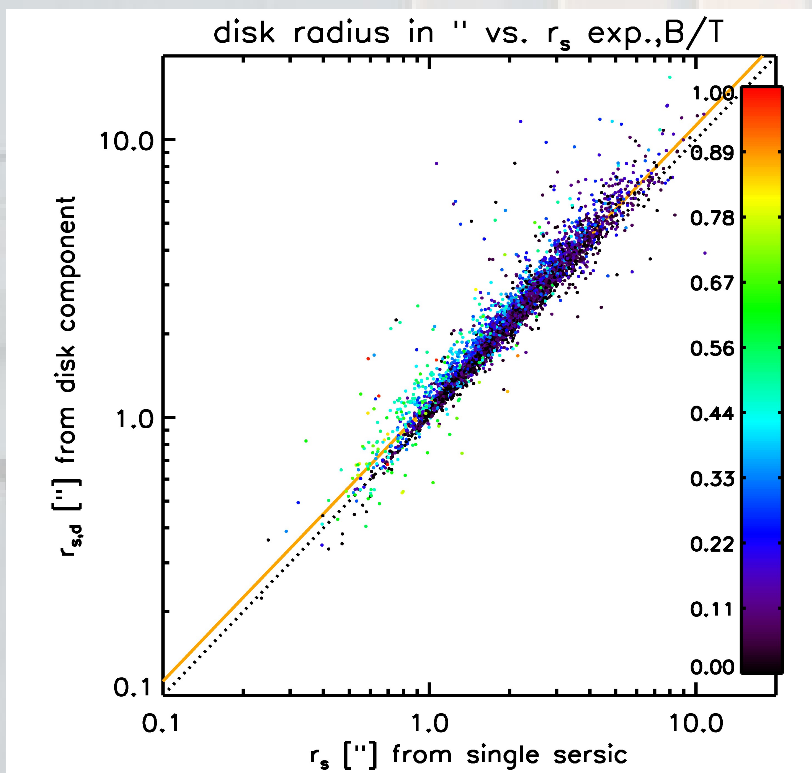
→ SF linked to ambient IGM

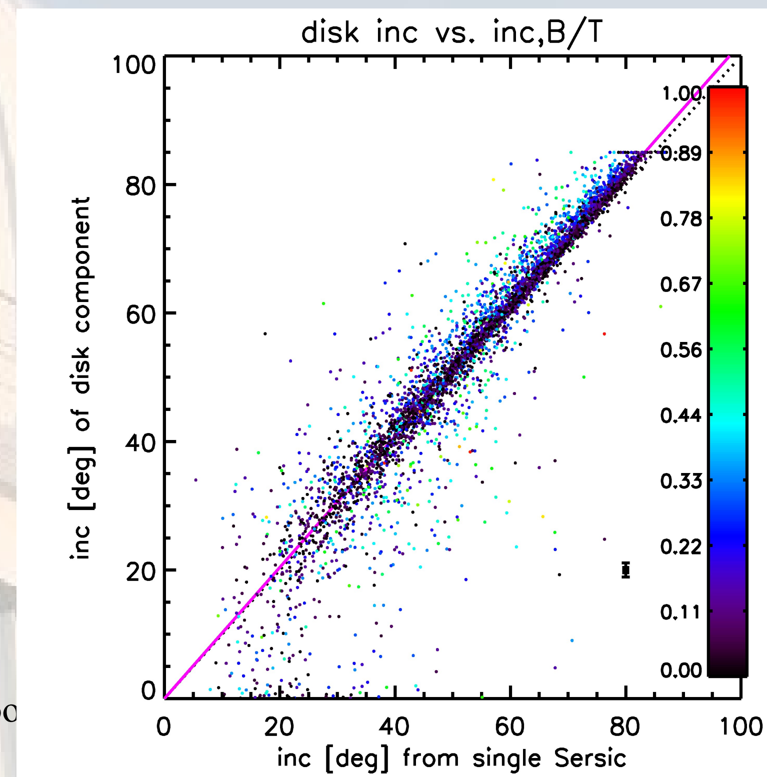
- Get SFR from integrated galaxy properties; Use NUV SFR

- Minimize evolutionary effects; $z \leq 0.13$


Distribution of B/T in sample
Number
B/T


B/T vs. n
(B/T)r
single sersic index n

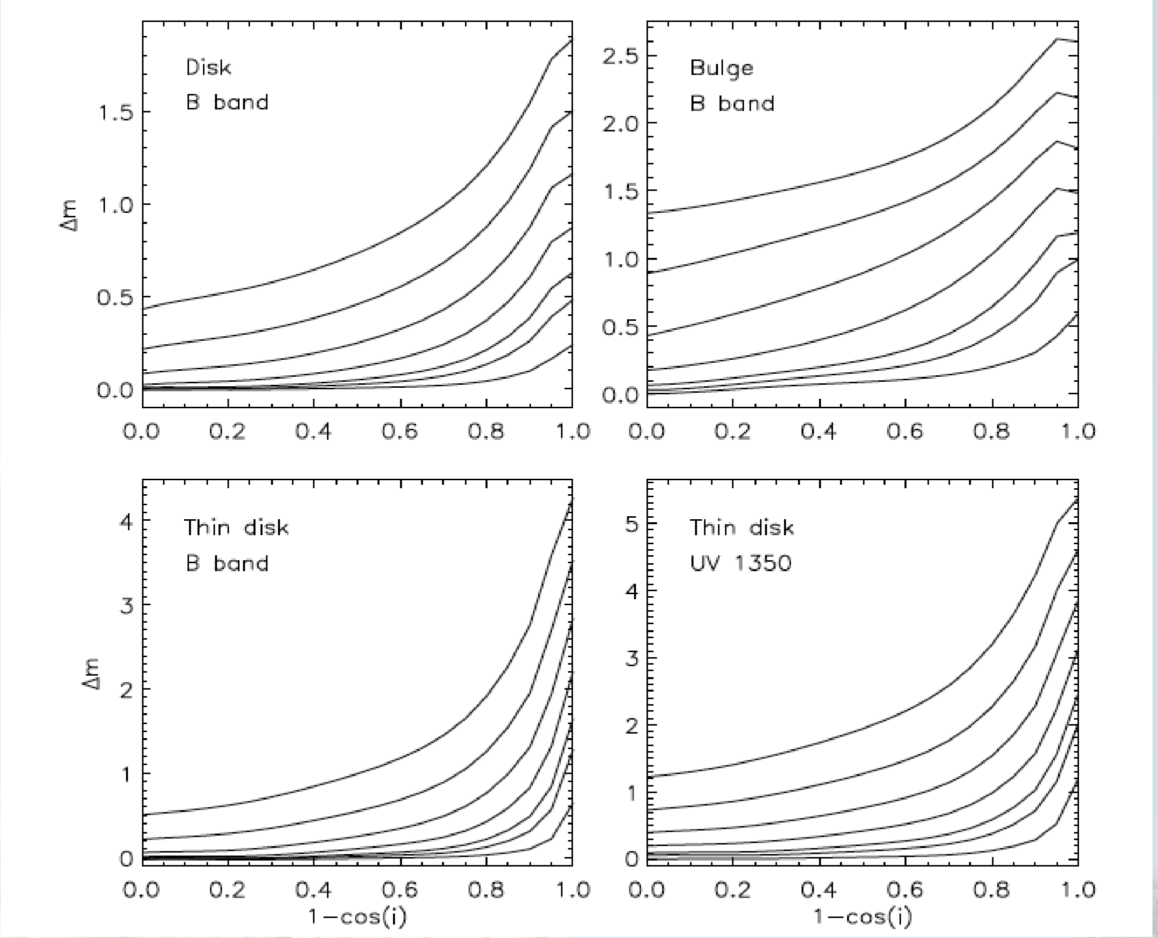

disk radius in " vs. r_s exp.,B/T
$r_{s,d}$ ['''] from disk component
r_s ['''] from single sersic


disk inc vs. inc,B/T
inc [deg] of disk component
inc [deg] from single Sersic

Dust Opacity – Stellar Mass Surface Density

- Use RT model of late-type rotationally supported systems to determine attenuation due to dust (Popescu et al., 2011)

- Necessary inputs:
  - τ^f ; Face-on dust optical depth
  - Inclination
  - B/D ratio



Tuffs et al., 2004