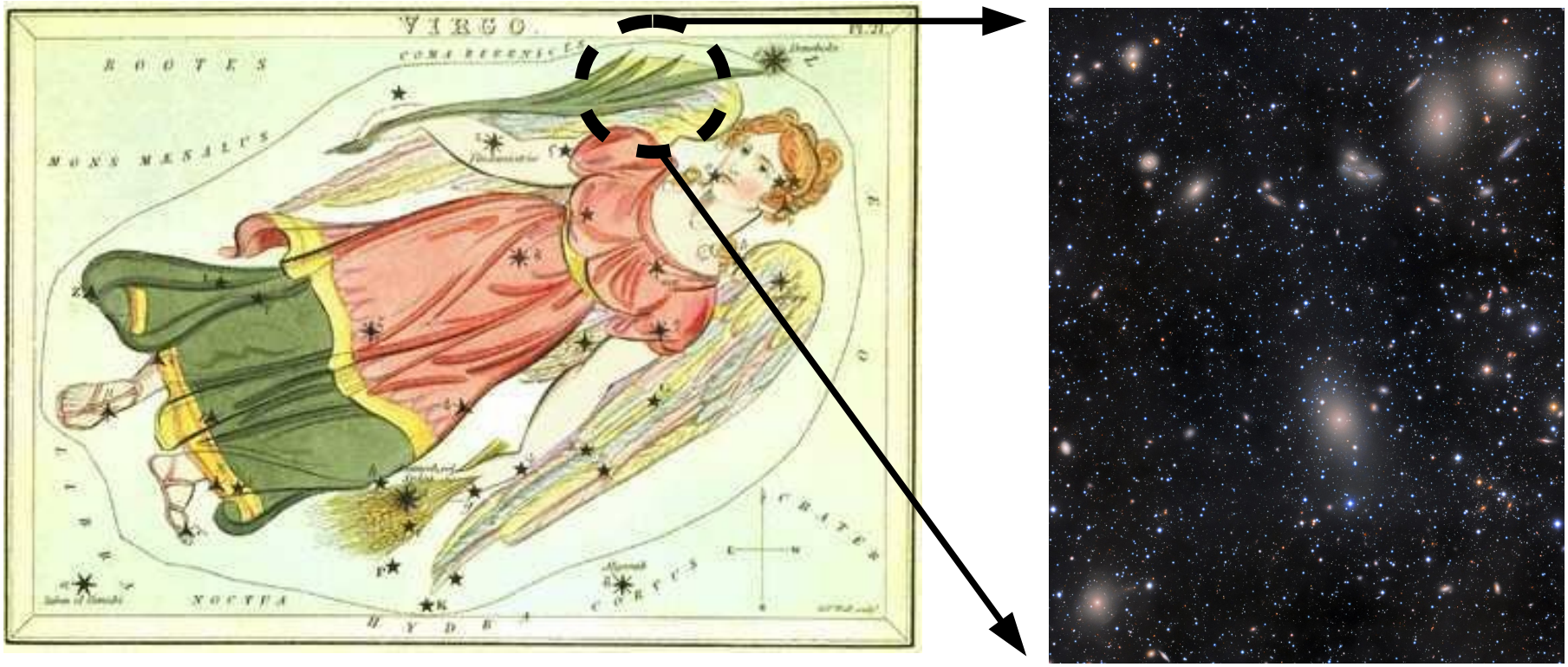
The Stellar Mass Perspective on the Virgo Cluster



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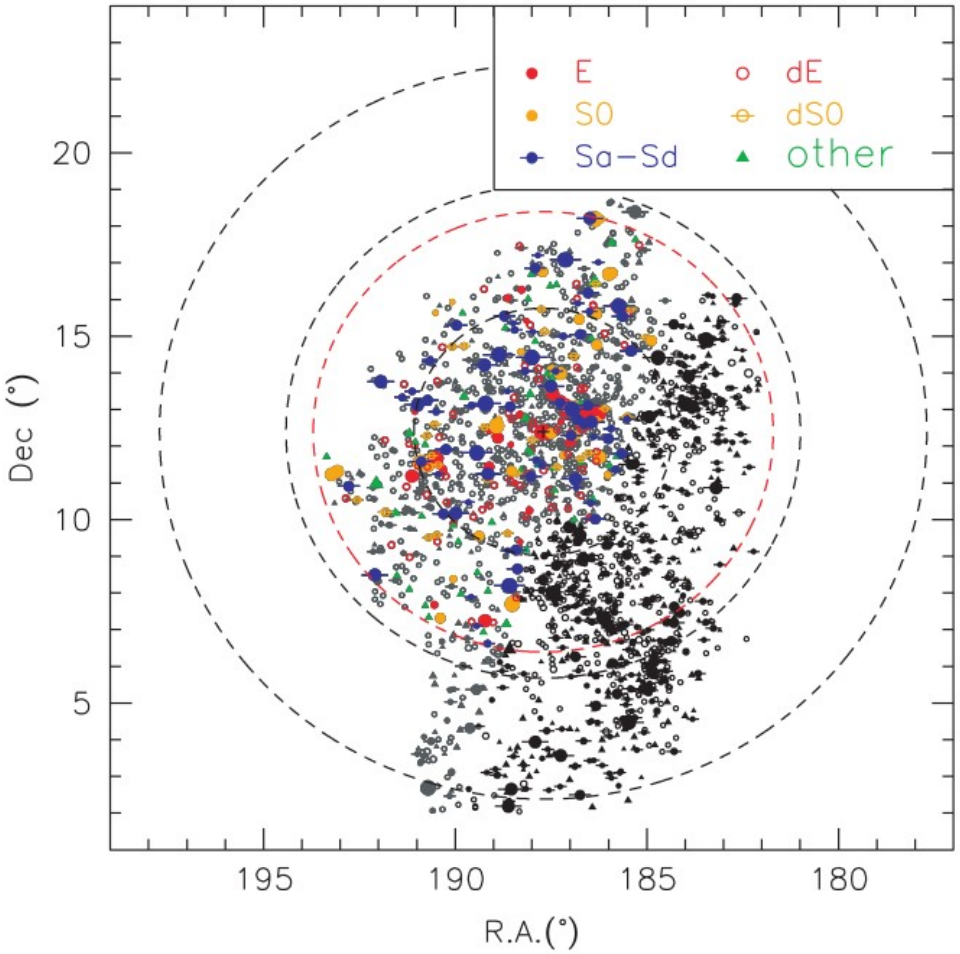
The SHIVir survey

(**S**pectroscopy & **H**-band **I**maging of **Vir**go cluster galaxies)

- *grizH* light profiles for 286 galaxies with $M_B \leq$ -15 (McDonald +11)
- $D_{M87} \sim 0 - 1.8$ Mpc
  $\Sigma \sim 3 - 15$ Mpc^{-2}
- Long-slit optical spectra in emission/absorption for ~230 galaxies (Ouellette+, *in prep.*)



McDonald +09, 11

Virgo – summary of work to date

Reference	Topic(s)
Roediger +11a	Trends in **colours/colour gradients** of Virgo galaxies against morphology, galaxy structure & local environment
Roediger +11b	As above, but in terms of stellar **mean age** & **metallicity**
Roediger +12	Comparison of **age gradients** of **individual** Virgo disks against predictions of **hydrodynamic simulations** (albeit of field galaxies) in light of their **light profile shapes** (re: stellar migrations)

Galaxy type	Gradient(s)*		
	g–H	$< A >$	*Z*
E/S0	– (W)	+/flat (W)	– (M/W)
dE/dS0	– (S)	+/flat (W)	– (M)
Spirals	– (S)	+ → – (W)	– (M/S)

* Significant dispersions for each galaxy type

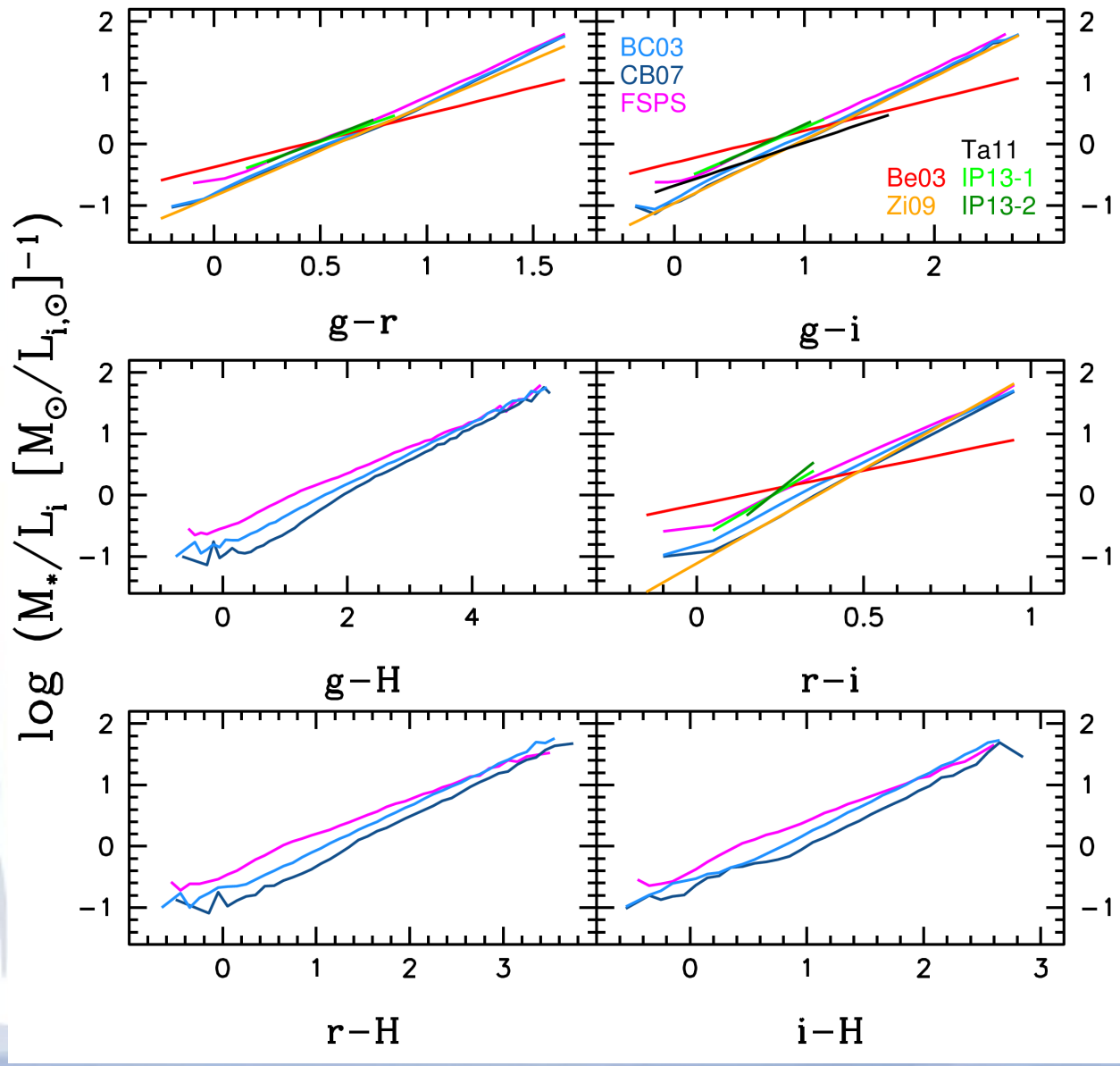
W = weak,
M = mild,
S = strong

How can we add to those results?

Quantity	Definition	(Loose) Meaning
$< A >$	$\int t \cdot SFR(t) \cdot \mathrm{d}t$	Shape of SFH
Z	-	Enrichment history
M_*	$\int SFR(t) \cdot \mathrm{d}t$	**Star formation efficiency history**

- Interesting questions related to M_*:
  - what is the M_* budget for the Virgo cluster?
  - how are galaxies in Virgo structured by mass?
  - what is the <u>empirical</u> M_*–M_{halo} relation?

Measuring stellar masses



BC03 = Bruzual & Charlot 2003

CB07 = Charlot & Bruzual 2007

FSPS = Conroy +09

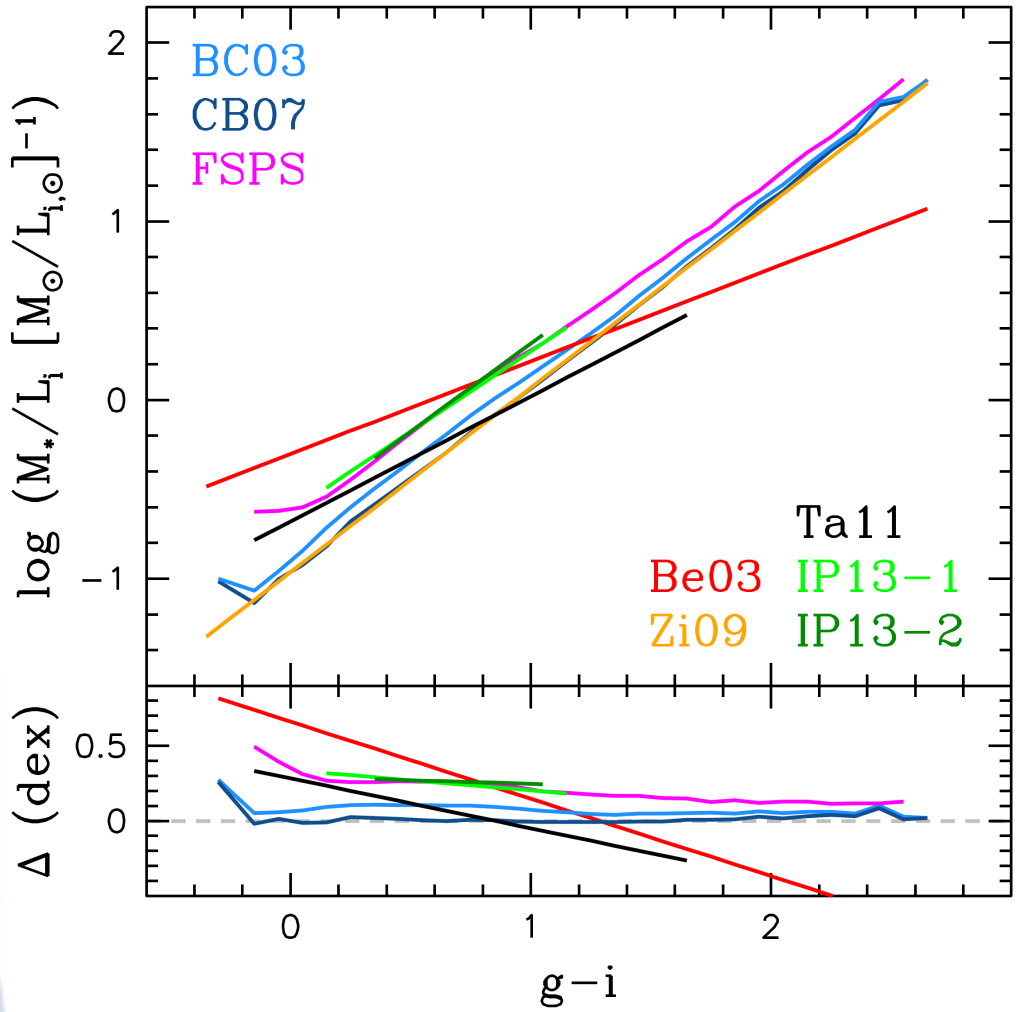
Be03 = Bell +03

Zi09 = Zibetti +09

Ta11 = Taylor +11

IP13 = Into & Portinari 2013

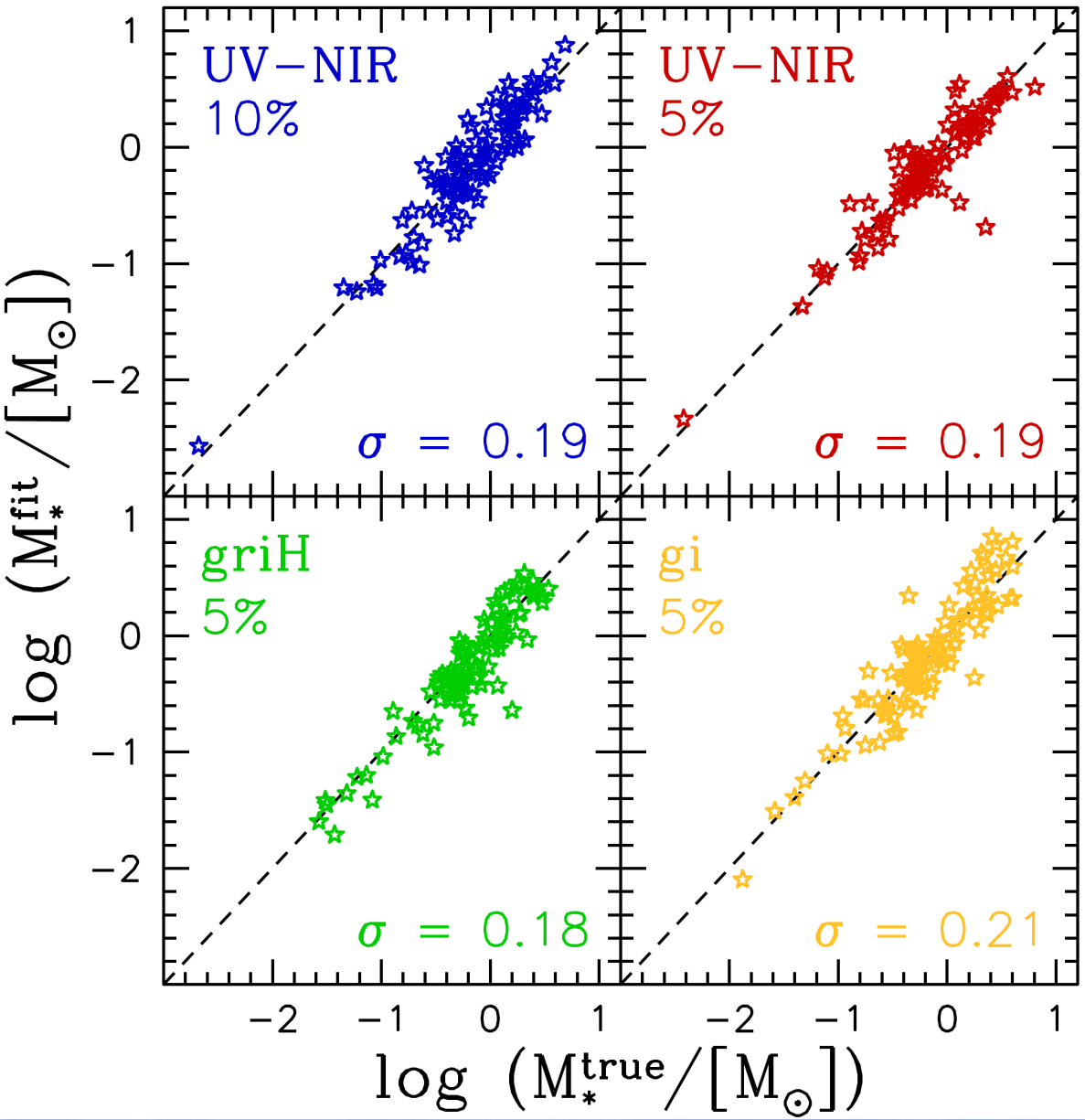
Systematics in M_* estimation



Note: Be03 &Ta11 relations calibrated on real galaxies

- Relations for optical colours differ by ≤ 0.3 dex, driven by model ingredients & priors (see also Pforr +12)
- Other systematics – fitting method, number of spatial dimensions (≤ 0.2 dex; see also Zibetti +09)

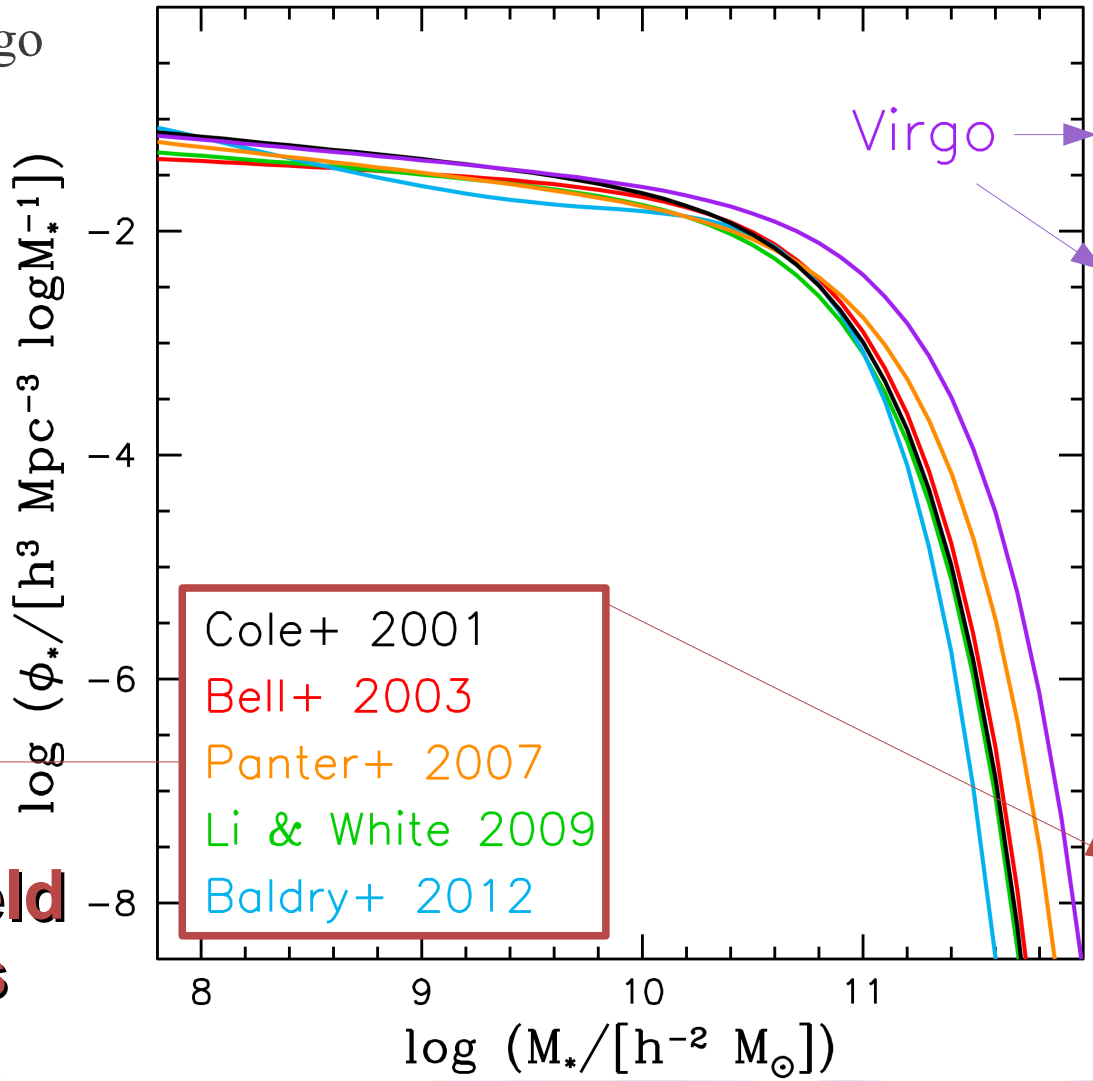
Intrinsic accuracy of M_* estimates



M_* can be estimated to within ~40% b/o g–i colours alone!

The distribution of M_* amongst local galaxies

Note: M_* for Virgo galaxies pertain to g–i colours measured within $R_{23.5,i}$



Virgo → $\alpha \sim -1.18 - 1.16$, $M^* \sim 10^{10.5\text{-}10.8}\ M_{Sun}$

re-normalized for comparison

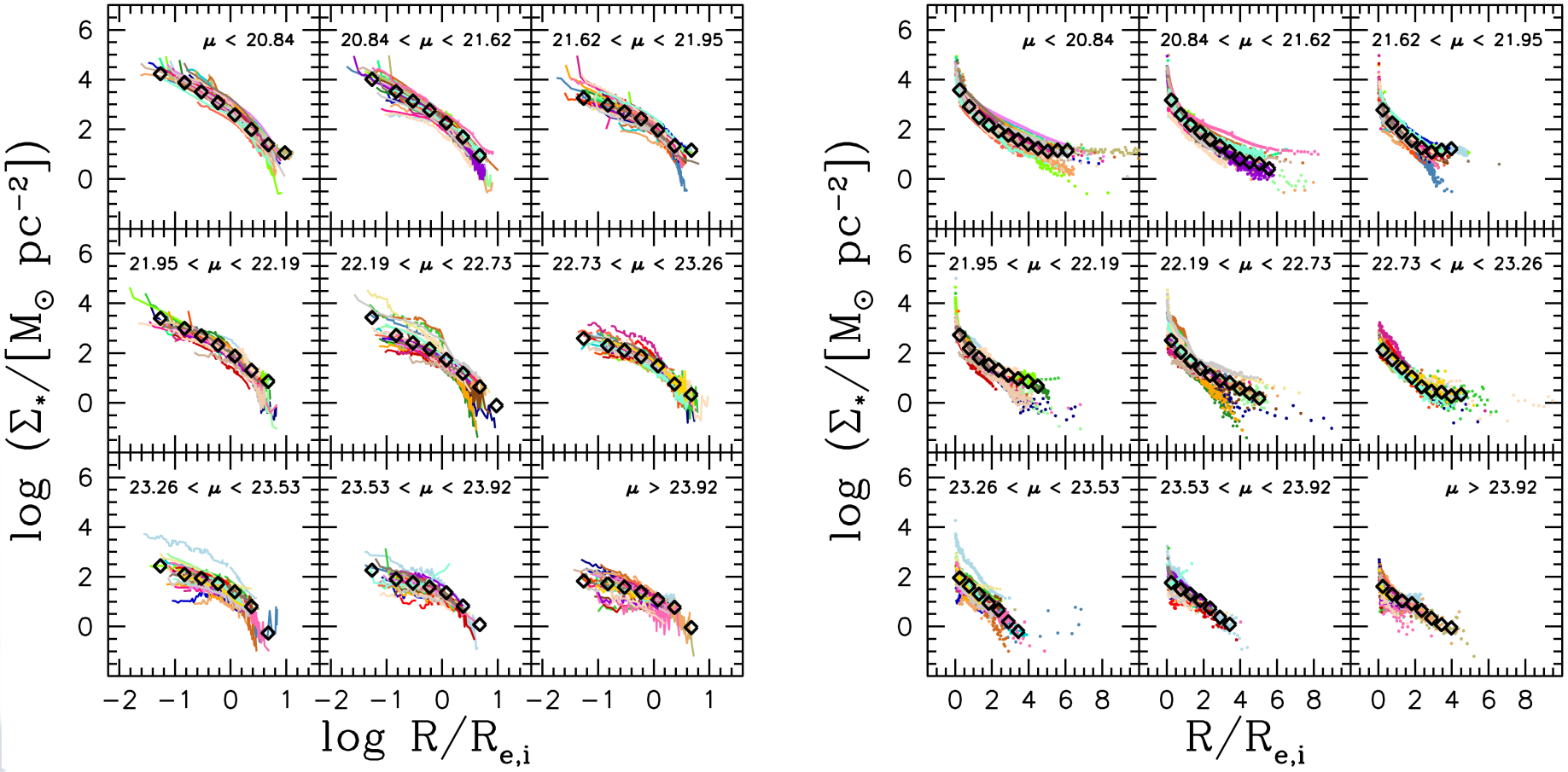
$\alpha \sim -1.22 - 1.10$, $M^* \sim 10^{10.2\text{-}10.7}\ M_{Sun}$

Largely field galaxies

The distribution of M_* within Virgo galaxies

Inner regions

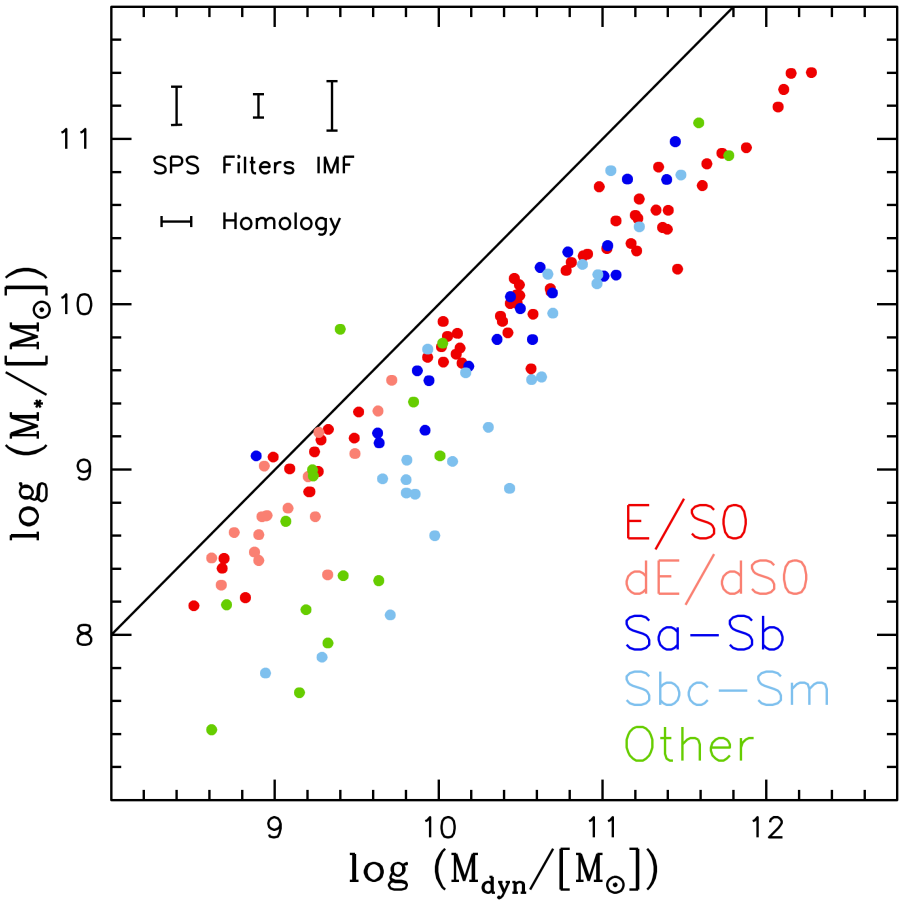
Outer regions

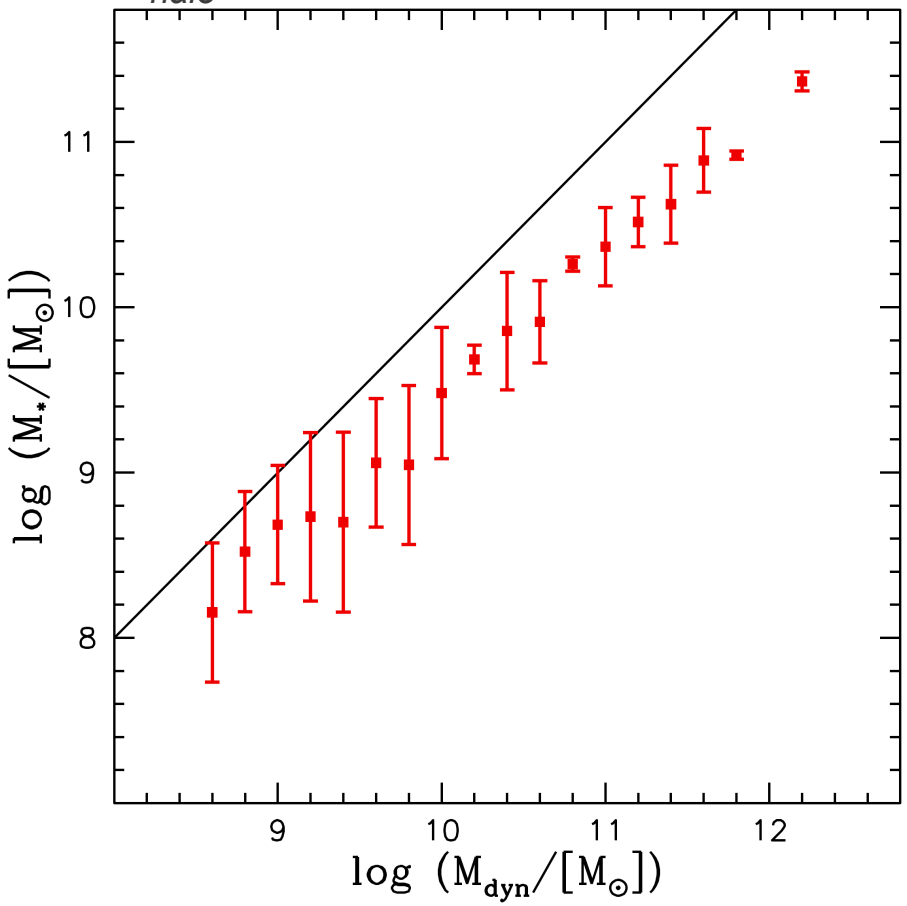


Weaker trends found against *B/T*, C_{28} and *L*

The Virgo M_*–M_{dyn} relation

(a proxy for the M_*-M_{halo} relation)

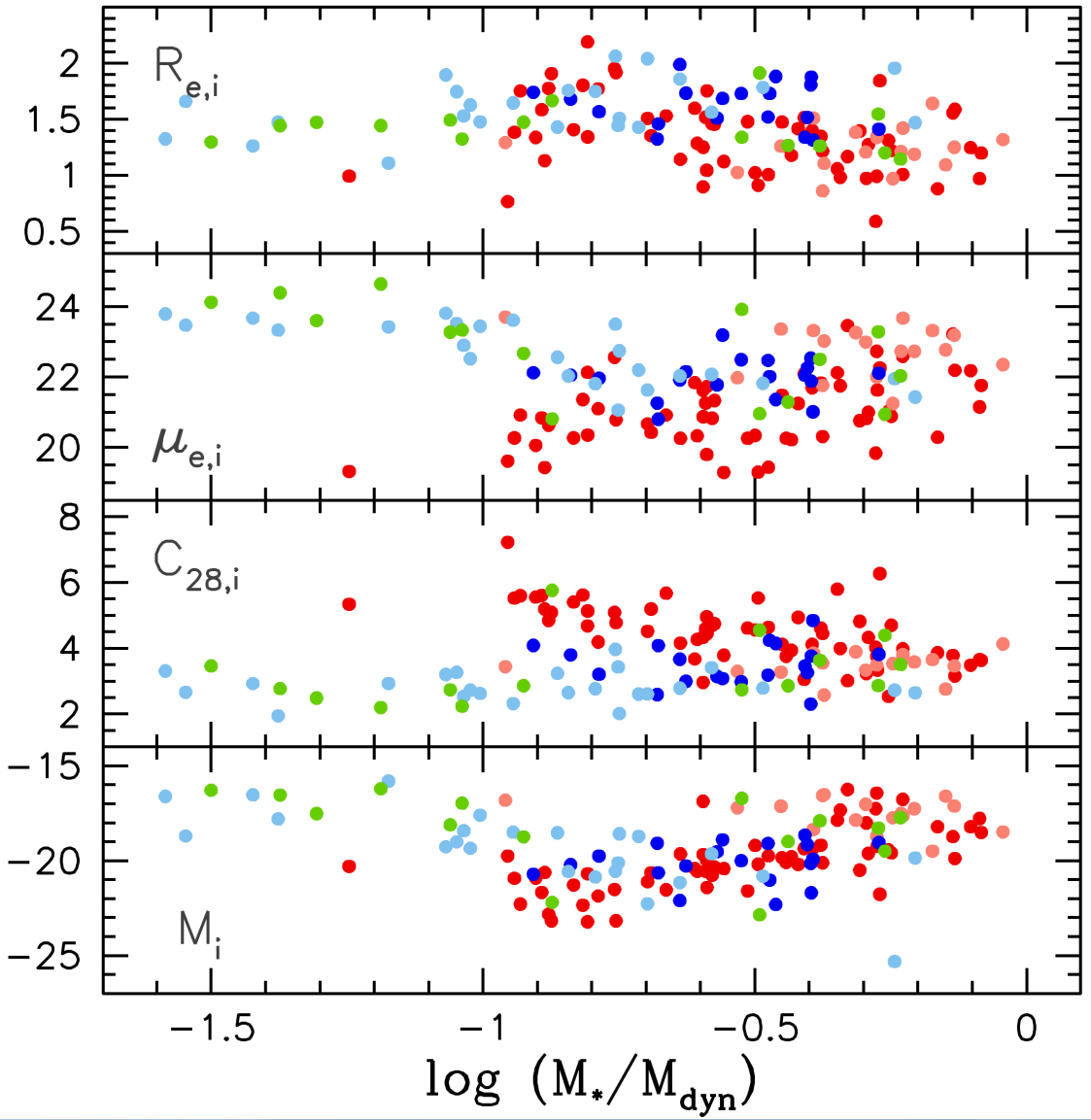




For E/S0 + dE/dS0 + Sa-Sb's, $M_* \sim M_{dyn}^{\beta}$, β drops to high M_{dyn}

Scatter in M_* increases with M_{dyn} from 0.2-0.6 dex (!)

Trend(s) in stellar/dark matter fraction with galaxy structure



More dark-to-stellar matter

More stellar-to-dark mass

Summary

- Higher proportion of massive galaxies found in Virgo ($M^* \sim 10^{10.8\text{-}11}$ M_{Sun}) relative to field ($M^* \sim 10^{10.2\text{-}10.7}$ M_{sun})
  - global environment matters (see also Calvi +13)
- Amongst (B/T, C_{28}, M, μ_e, R_e), shapes of stellar mass density profiles appear to be best predicted by μ_e
  - M_*/L does not vary strongly with radius, on average
- Scatter in M_* at fixed M_{dyn} amounts to ~0.2-0.5 dex, and DM fraction within galaxies ~ f(C_{28}, galaxy type)
  - "weak (strong)" feedback in high-C_{28} early-types (late-types) lead to halo contraction (expansion)?

Pondering the future

Use/obtain ...

(1) deep optical imaging of Virgo to fully characterize galaxy population to $10^{5\text{-}6}$ M_{Sun}

(2) LOS velocities of Virgo dwarfs and spirals to constrain their cluster-centric orbits

(3) spatially-resolved (deep/wide-field) spectra of sub-sample ($N \sim$ 30-40) of SHIVir galaxies to derive their detailed stellar population + kinematic properties

(4) kinematic ($V_{rot}^{2} + \sigma^{2}$) profiles to estimate M_{halo}