Galaxy Scaling Relations with the SAMI Survey

. . . and beyond!

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Matthew Colless, SAMI Team

Research School of Astronomy & Astrophysics
Australian National University

September 20, 2016

Credit: D. Barat

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The Virial Theorem

1. The Fundamental Plane

$$\log L = a \log \sigma + b \log \mathrm{R} + c$$

2. The Virial Mass Estimator

$$M_{\mathrm{dyn}} \propto \sigma^2 \mathrm{R}$$

The Virial Theorem:

$$\sigma^2 = \alpha \frac{\mathrm{G\,M}}{\mathrm{R}}$$

$$\alpha = \alpha(\sigma)$$

$$\mathrm{and/or}$$

$$\mathrm{M}/L =: \Upsilon = \Upsilon(\sigma)$$

The Fundamental Plane 1 / 6

1. fitting algorithm
2. aperture size and shape for σ
3. magnitude
4. effective radius
5. sample selection (morphology, redshift, . . .)

$\rightarrow$ assess the methods using the observed RMS and MAD about the plane

The Fundamental Plane 1 / 6

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2. aperture size and shape for σ
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4. effective radius
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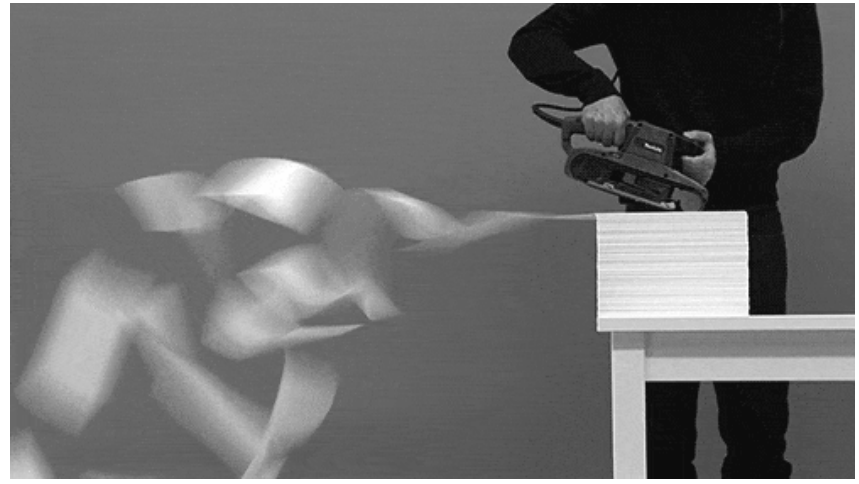
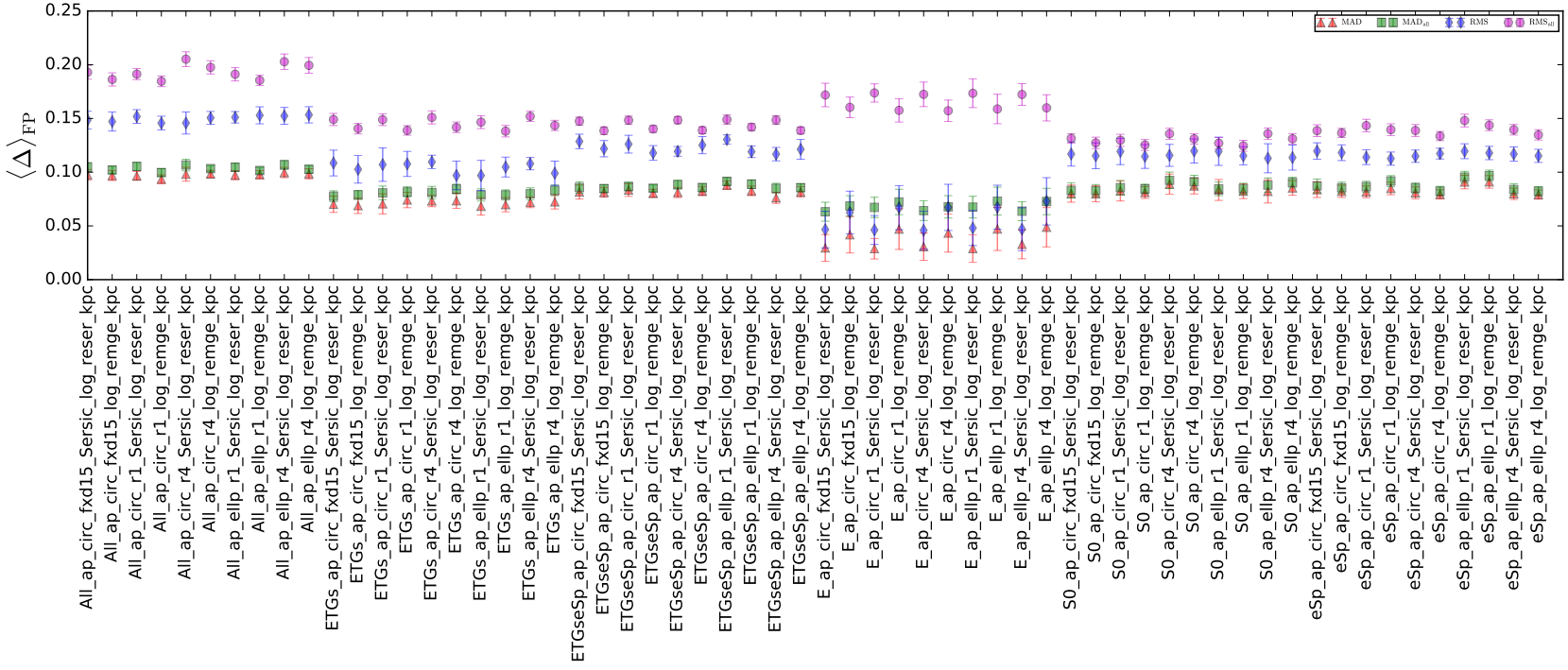


$\rightarrow$ assess the methods using the observed RMS and MAD about the plane

The Fundamental Plane 2 / 6

Comparing the effect of:

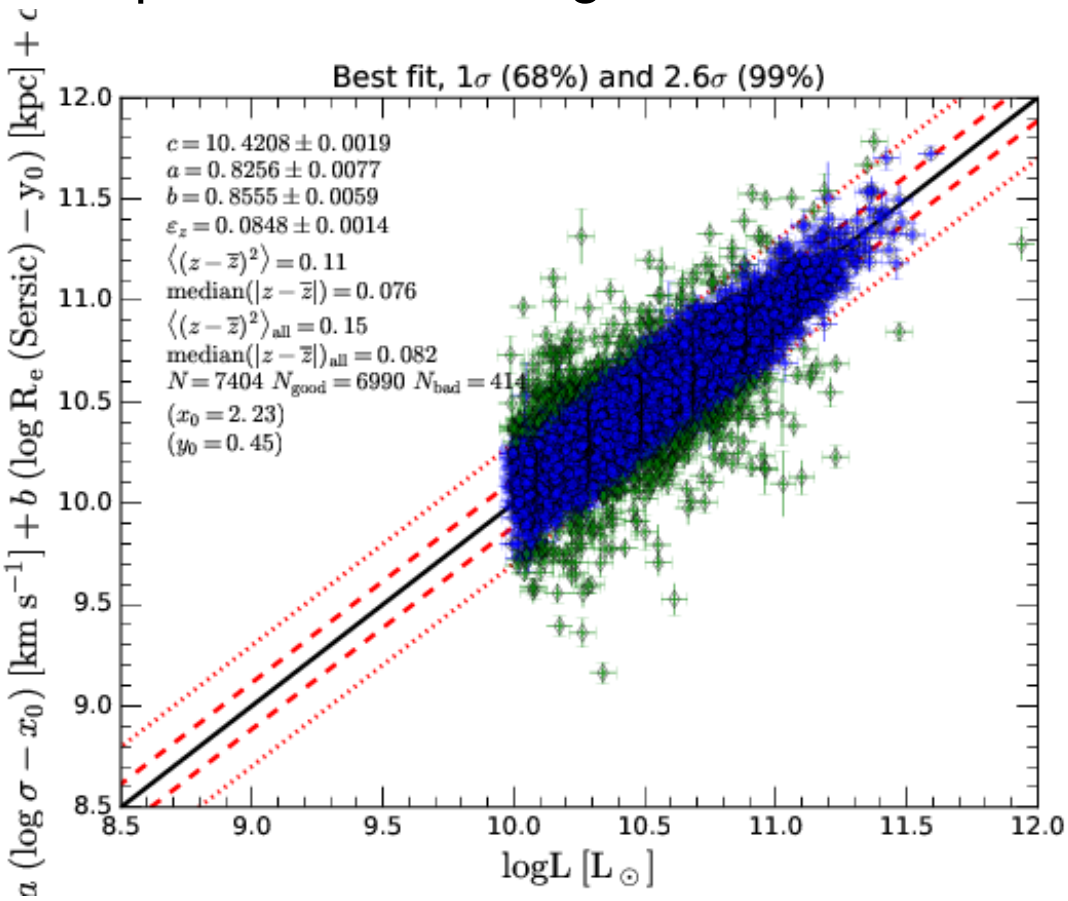
- morphology
- photometry
- aperture size/shape
- spectral resolution
- spatial resolution



The Fundamental Plane 3 / 6

Credit: D. Barat

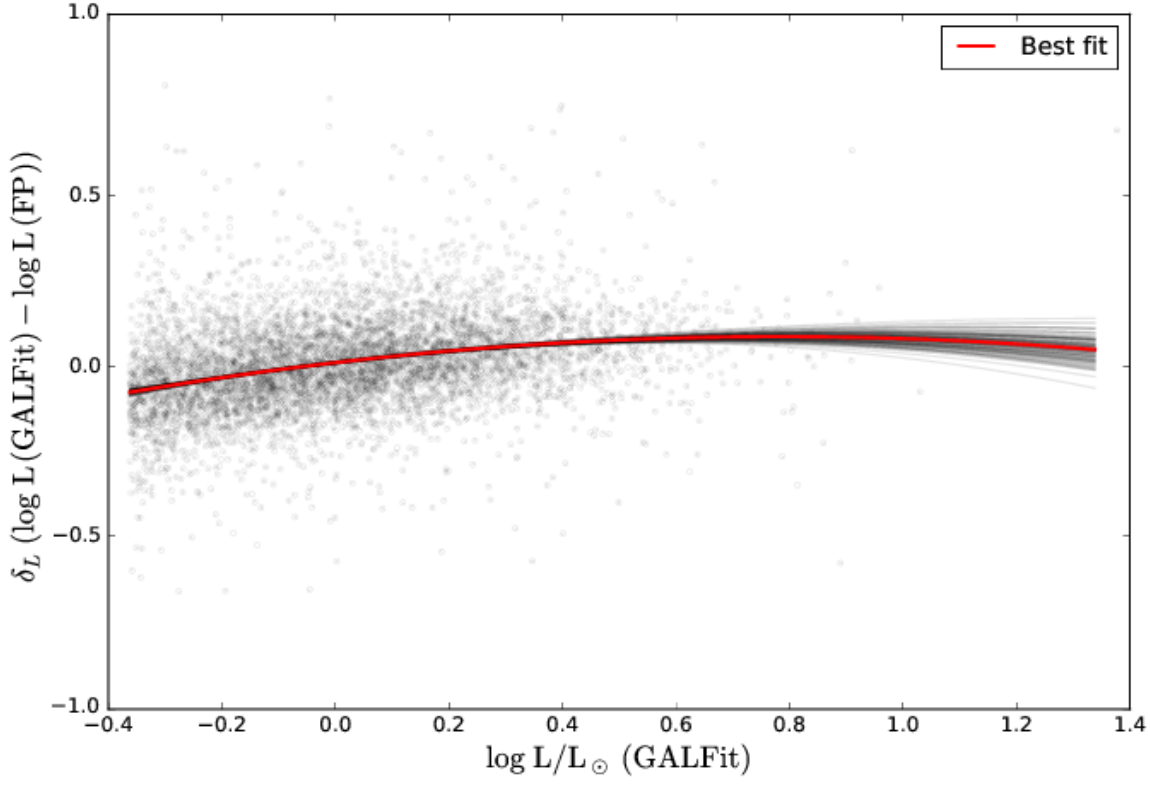
Warp in the FP: using an effective M/L to correct for the warp



RMS ≈ 0.11 dex

The Fundamental Plane 4 / 6

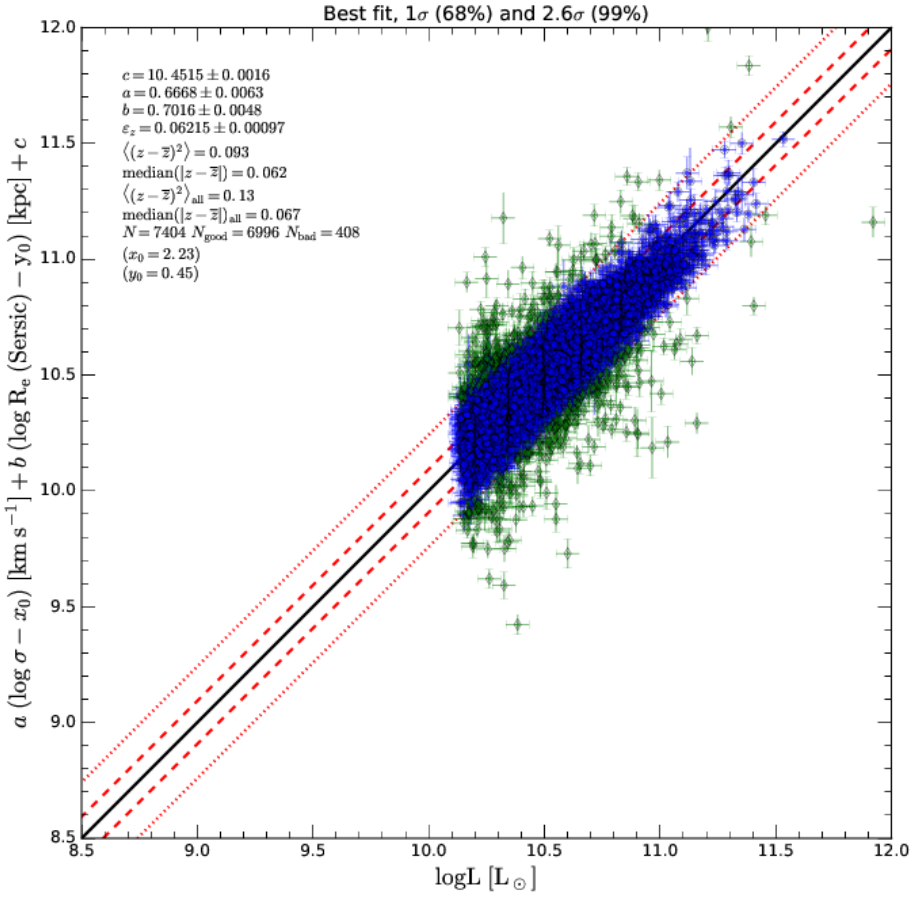
Warp in the FP: using an effective M/L to correct for the warp



The Fundamental Plane 5 / 6

Credit: D. Barat

Warp in the FP: using an effective M/L to correct for the warp

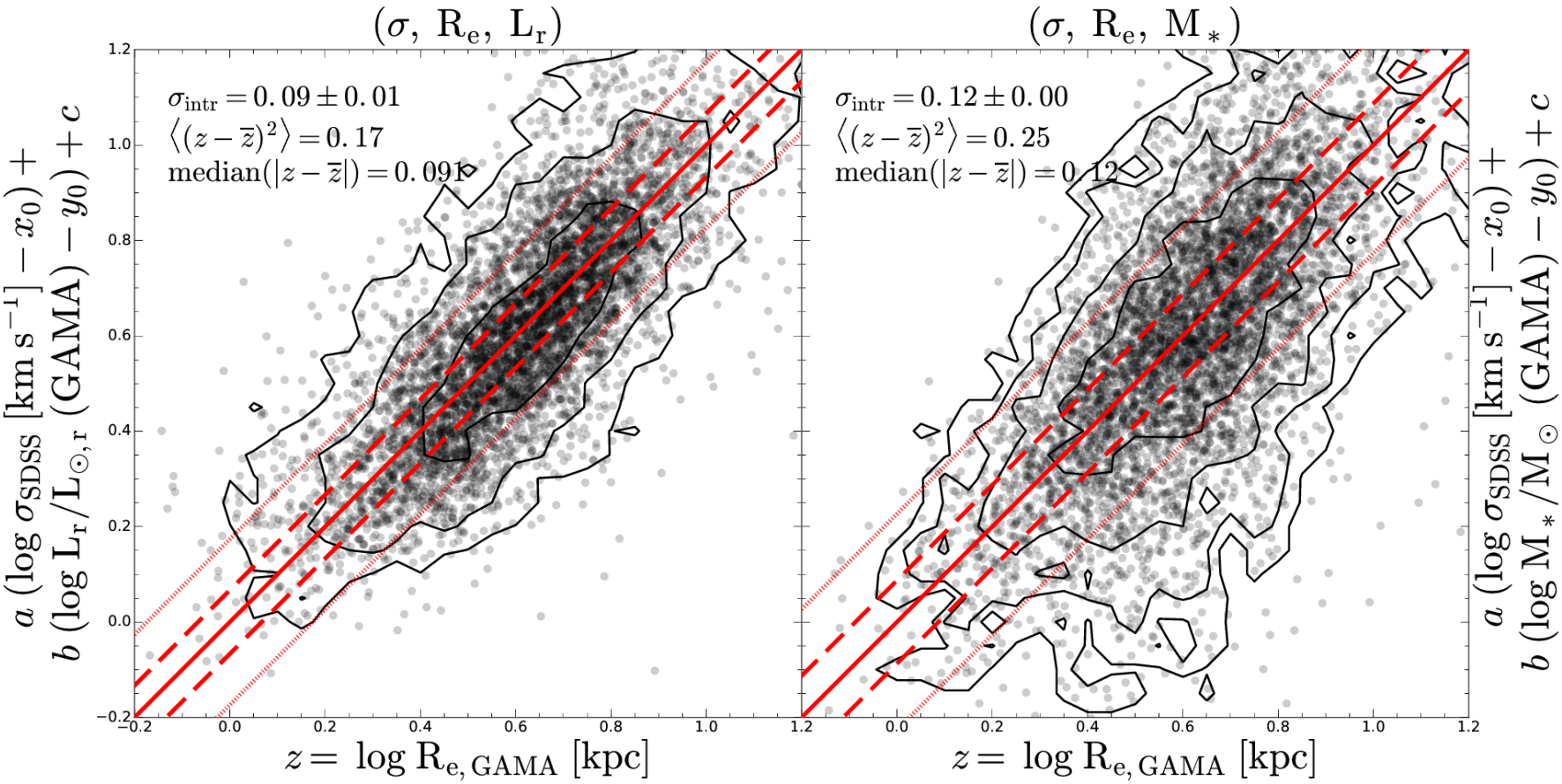


RMS -= 0.02 dex

Really the:
“Fundamental Buckled Paraboloid with Jagged Ends”

Credit: D. Barat

The Fundamental Plane 6 / 6



$\mathrm{M_*}$ does not help reduce the scatter

Credit: D. Barat

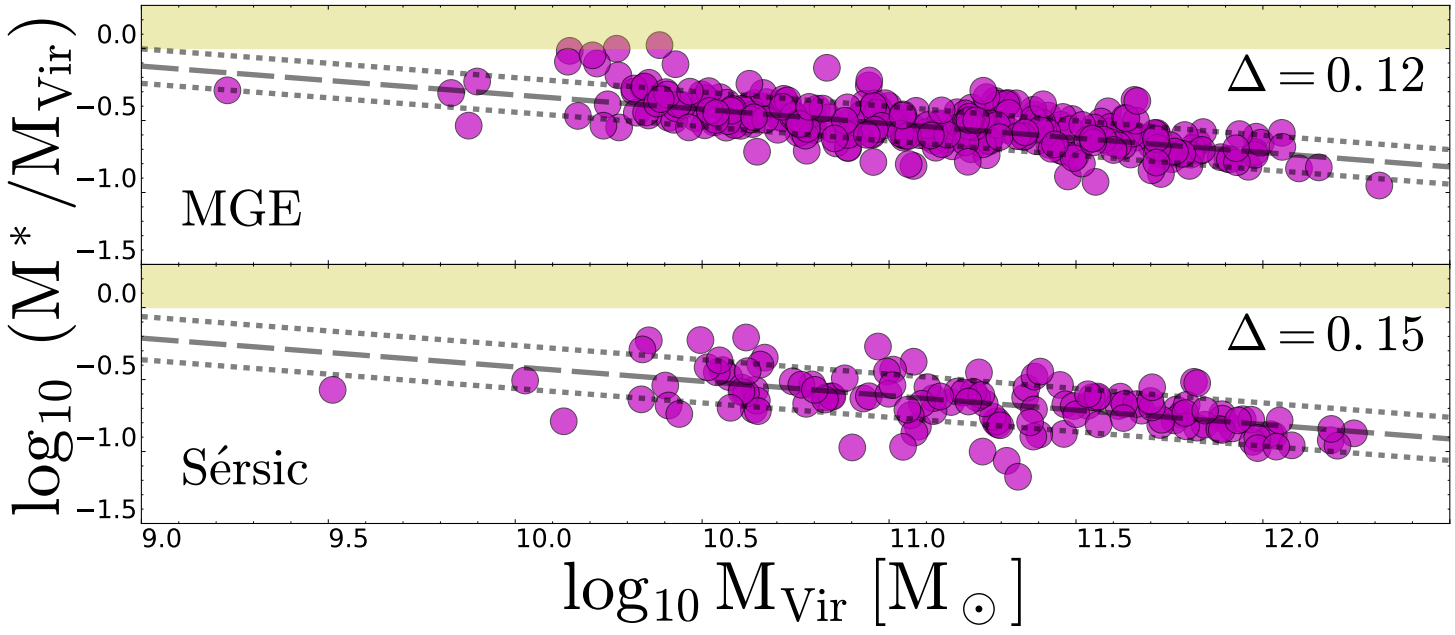
Summary (so far)

1. Single fibre is sufficient for cosmology applications
   ↳ . . . but photometry/aperture effects may appear for larger sample sizes (Hector?)
2. for Cosmology: use L or I; for galaxies: use M^*
3. Morphology & Warp are the main sources of scatter in the FP
4. . . .
5. . . .

Virial Mass estimator

Credit: D. Barat

Dynamical (Virial) vs Stellar Masses: SAMI ETGs



$$\text{MGE}: \log M_{Vir} = 2 \log \sigma + \log R_e^{maj} + \ldots$$

$$\text{Sérsic}: \log M_{Vir} = \beta(n) + 2 \log \sigma + \log R_e^{maj} + \ldots$$

$$\Delta(\log M^*/M_{Vir}) \approx 0.4 \text{ dex}$$

Virial Mass estimator

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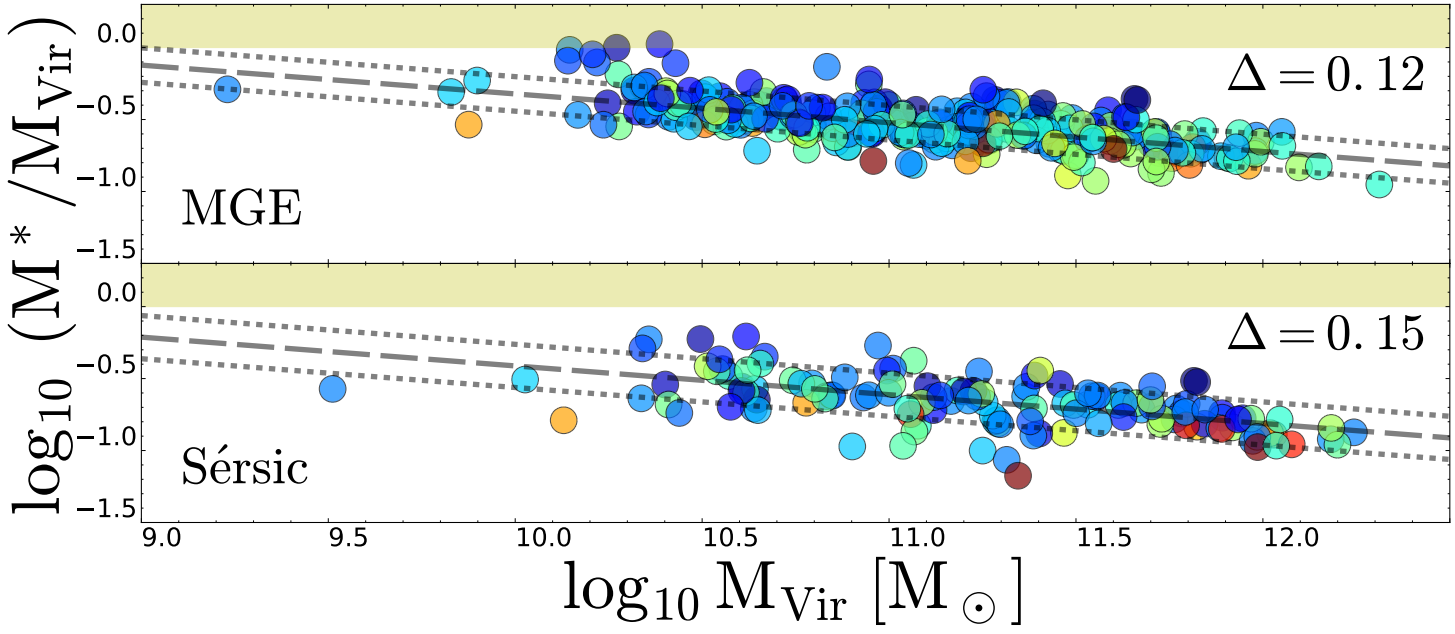

Trend with age?

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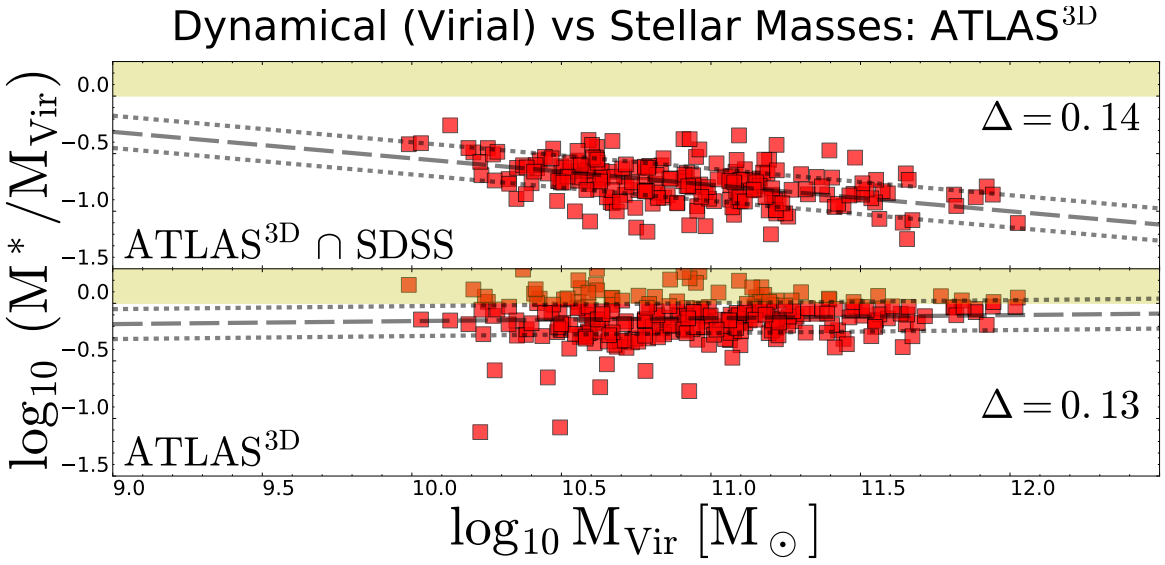
[Ages courtesy of N. Scott]

Credit: D. Barat

Virial Mass estimator



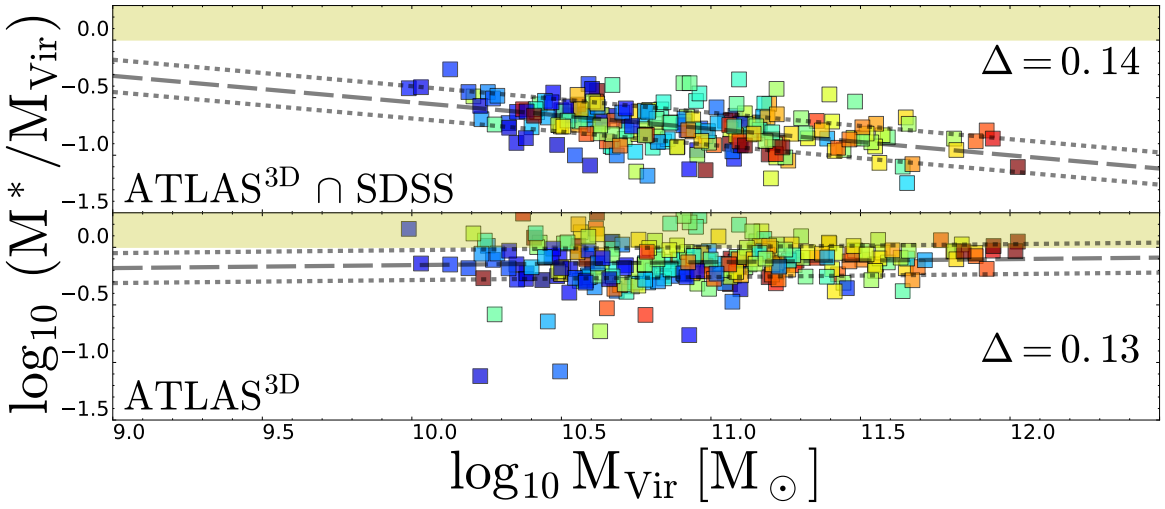
[Magnitudes courtesy of L. Cortese]

- SDSS magnitude: trend
- Alt magnitude: trend
- Spectroscopic M^*: no trend

(↳Typesetted by LaTeX)

Virial Mass estimator

Dynamical (Virial) vs Stellar Masses: ATLAS^{3D}

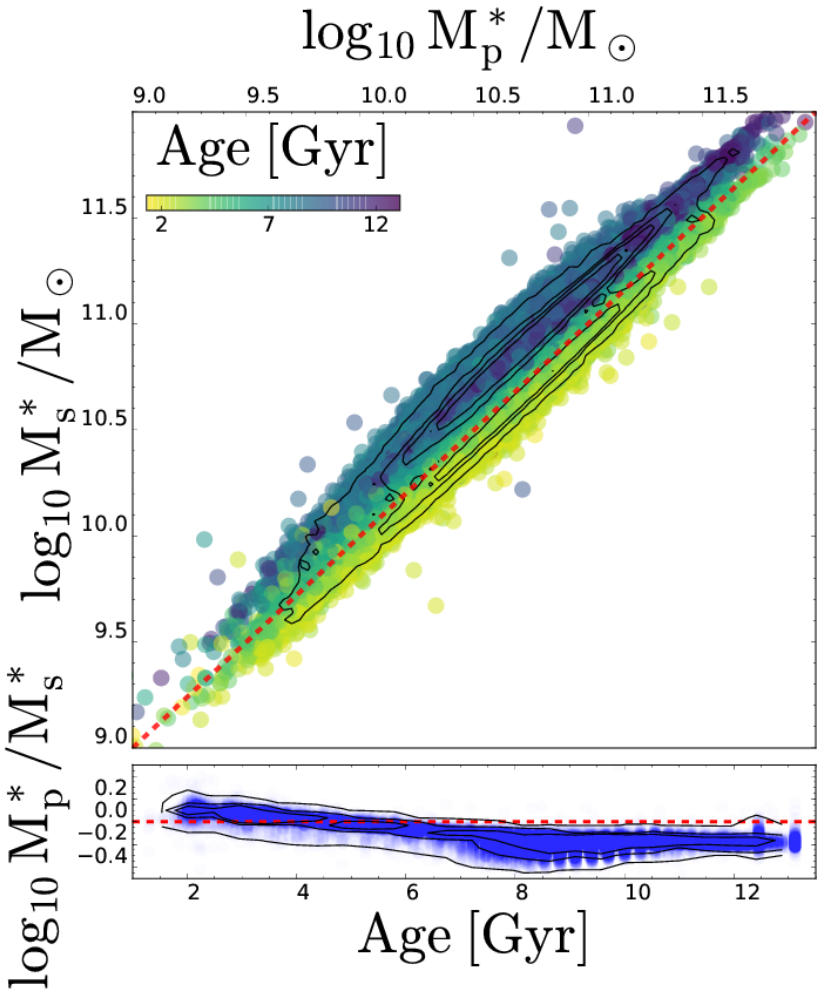


[Magnitudes courtesy of L. Cortese]

A trend with age?
(Take 2)

Credit: D. Barat

Origin of the bias



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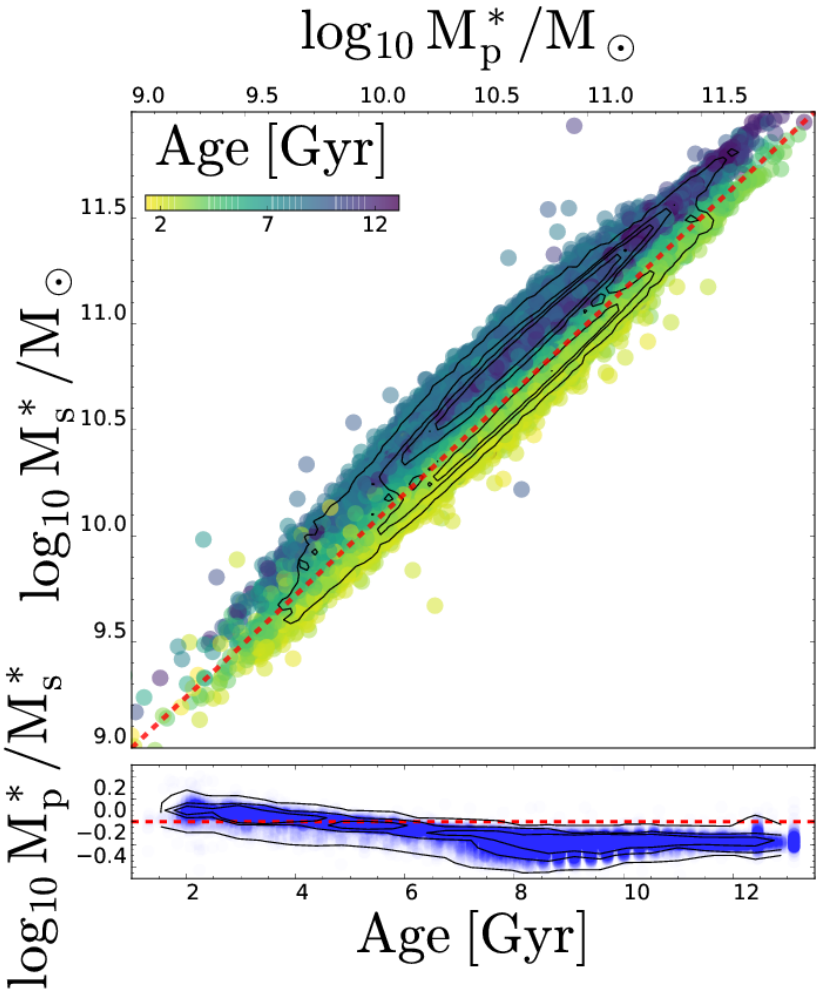

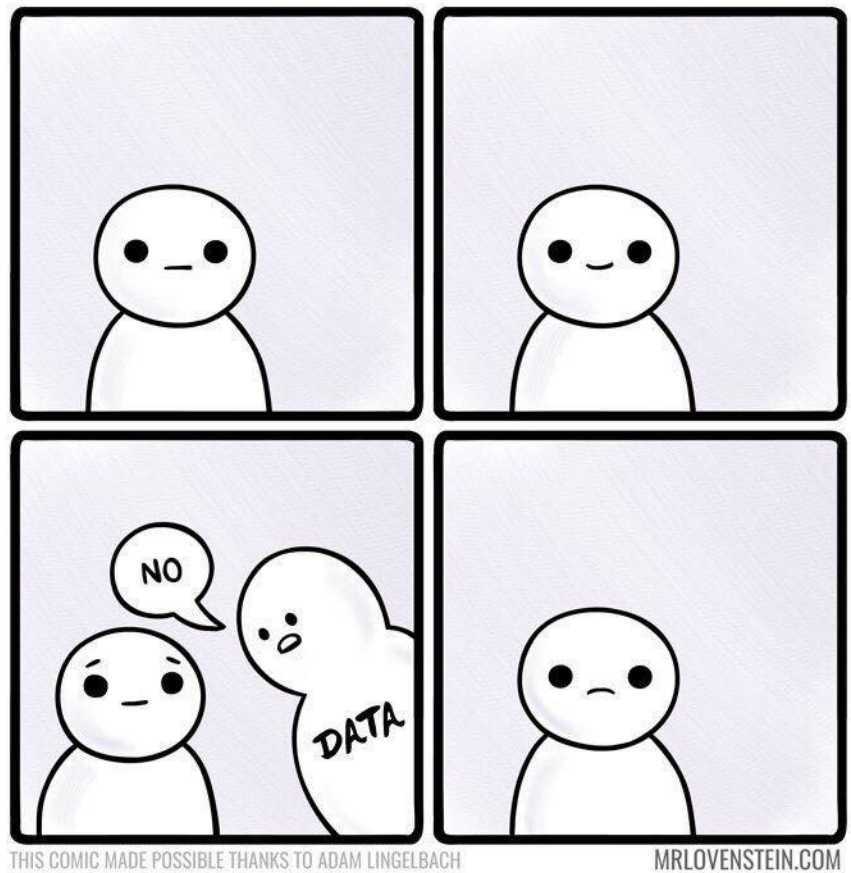

Credit: D. Barat

Summary and conclusions

1. Single fibre is sufficient for cosmology applications
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5. Use photometric stellar masses with care

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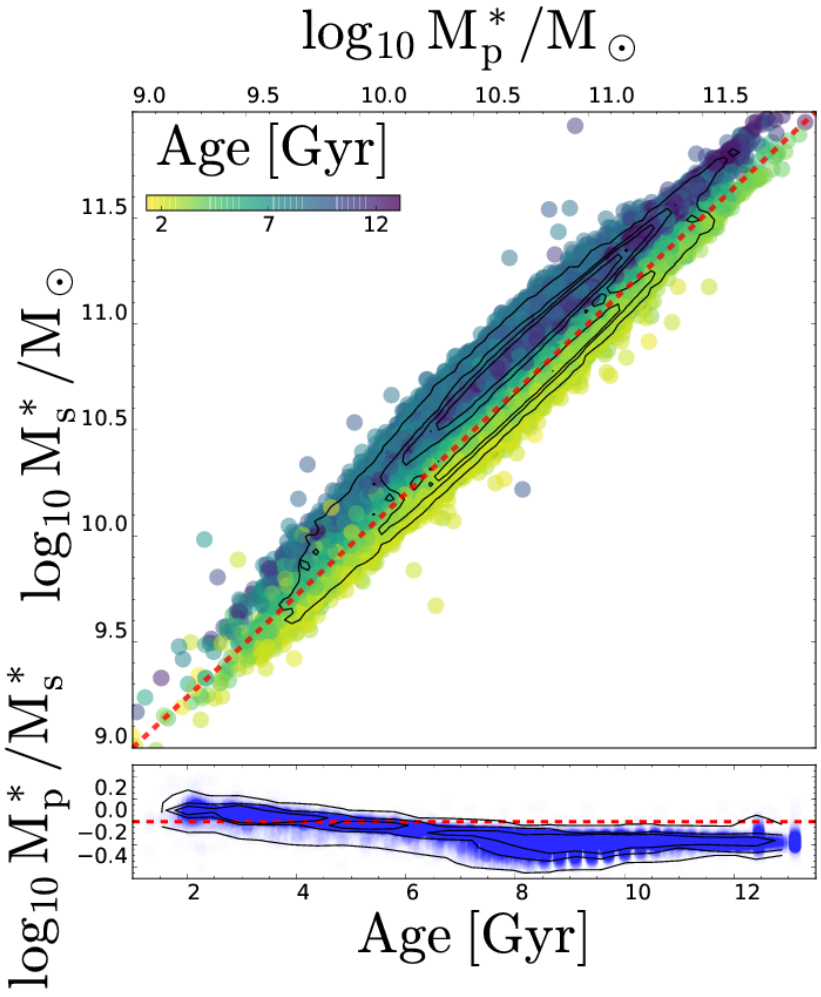
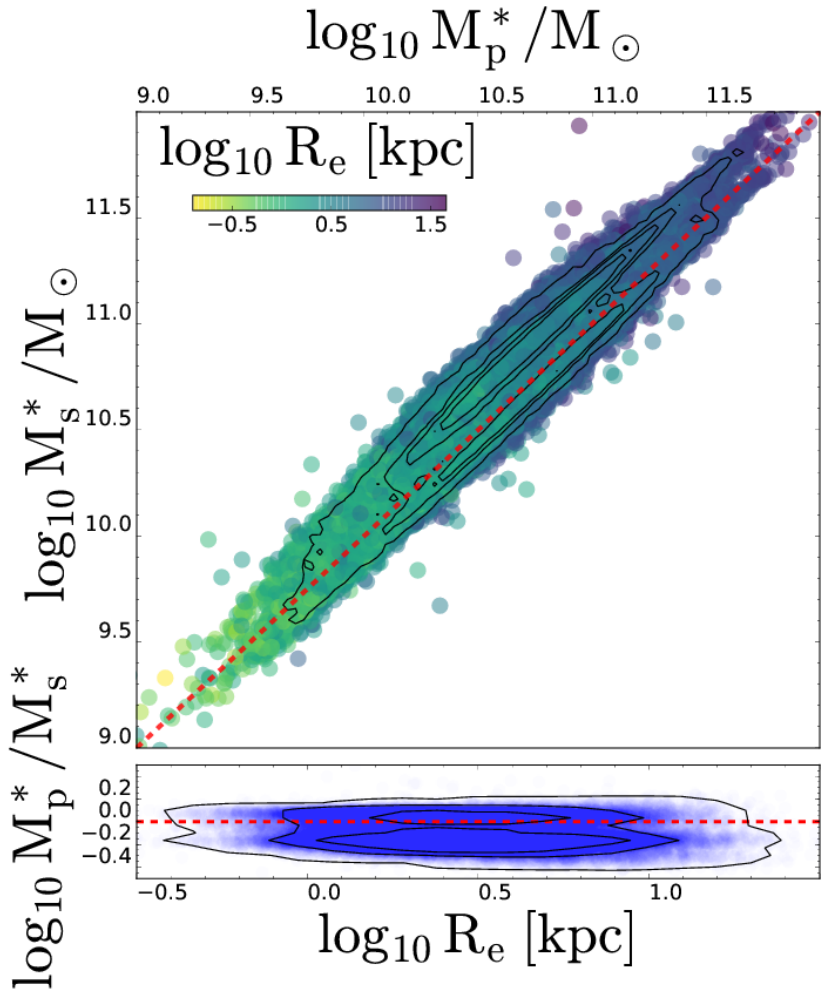
Future prospects

(This frame was intentionally left blank)

Credit: D. Barat

Origin of the bias





Origin of the bias

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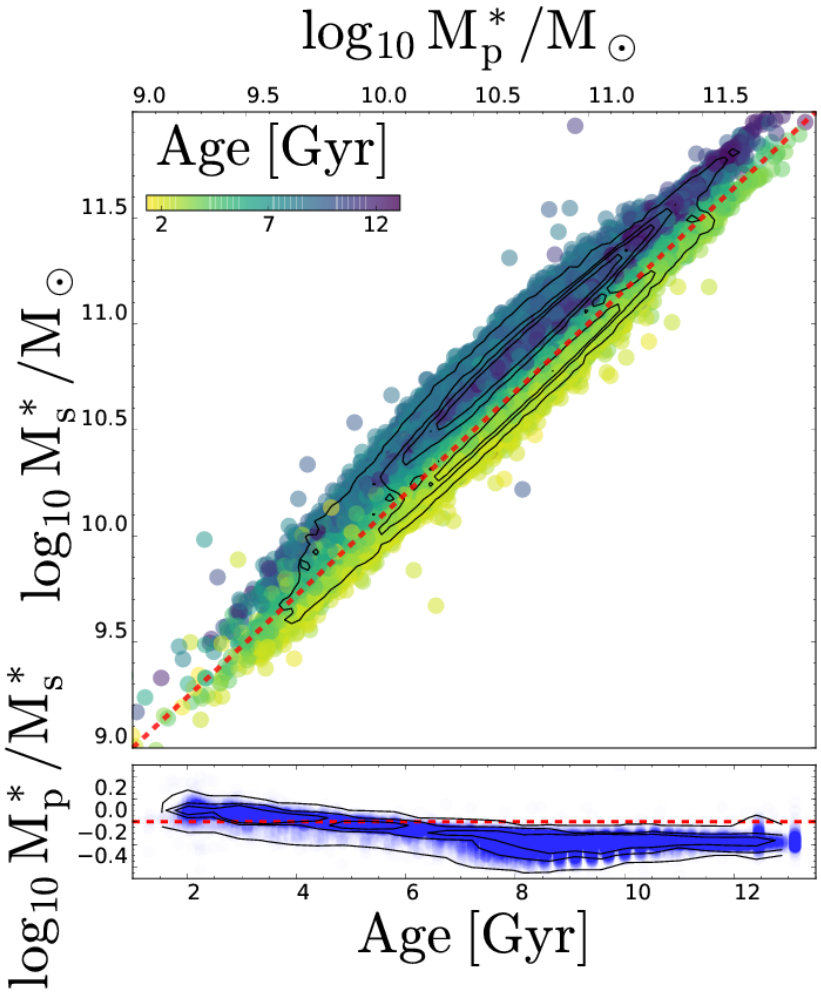

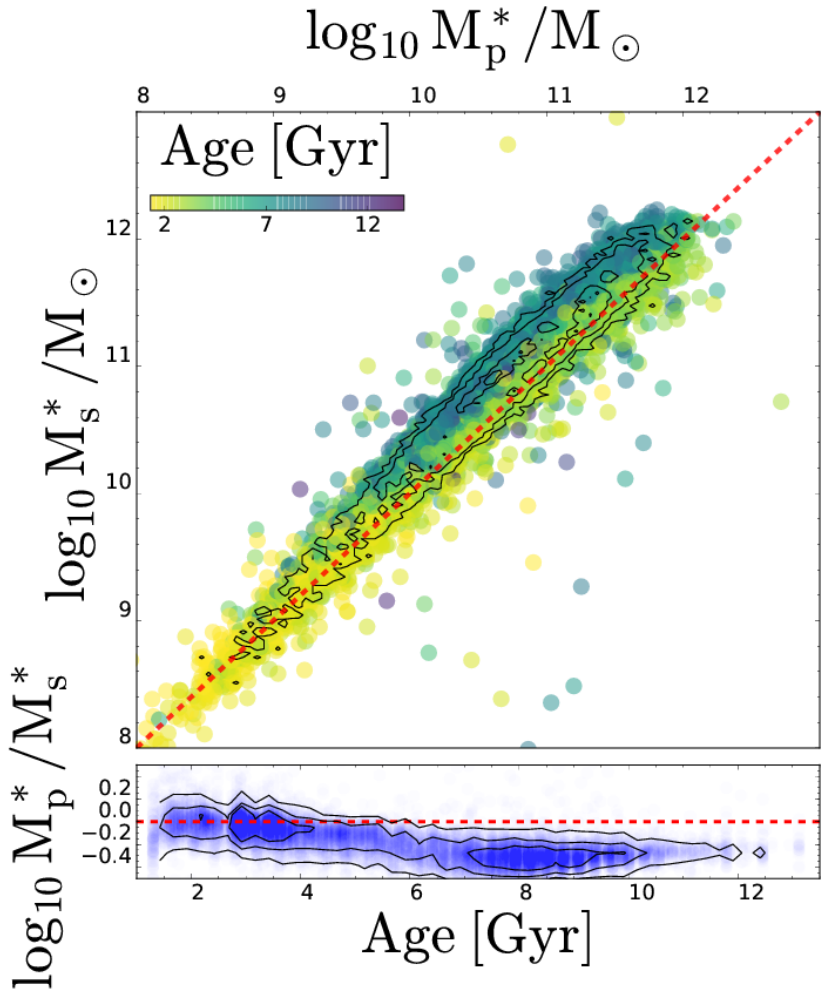

Fitting a line in LaTeX

Hi Brent, challenge accepted . . .