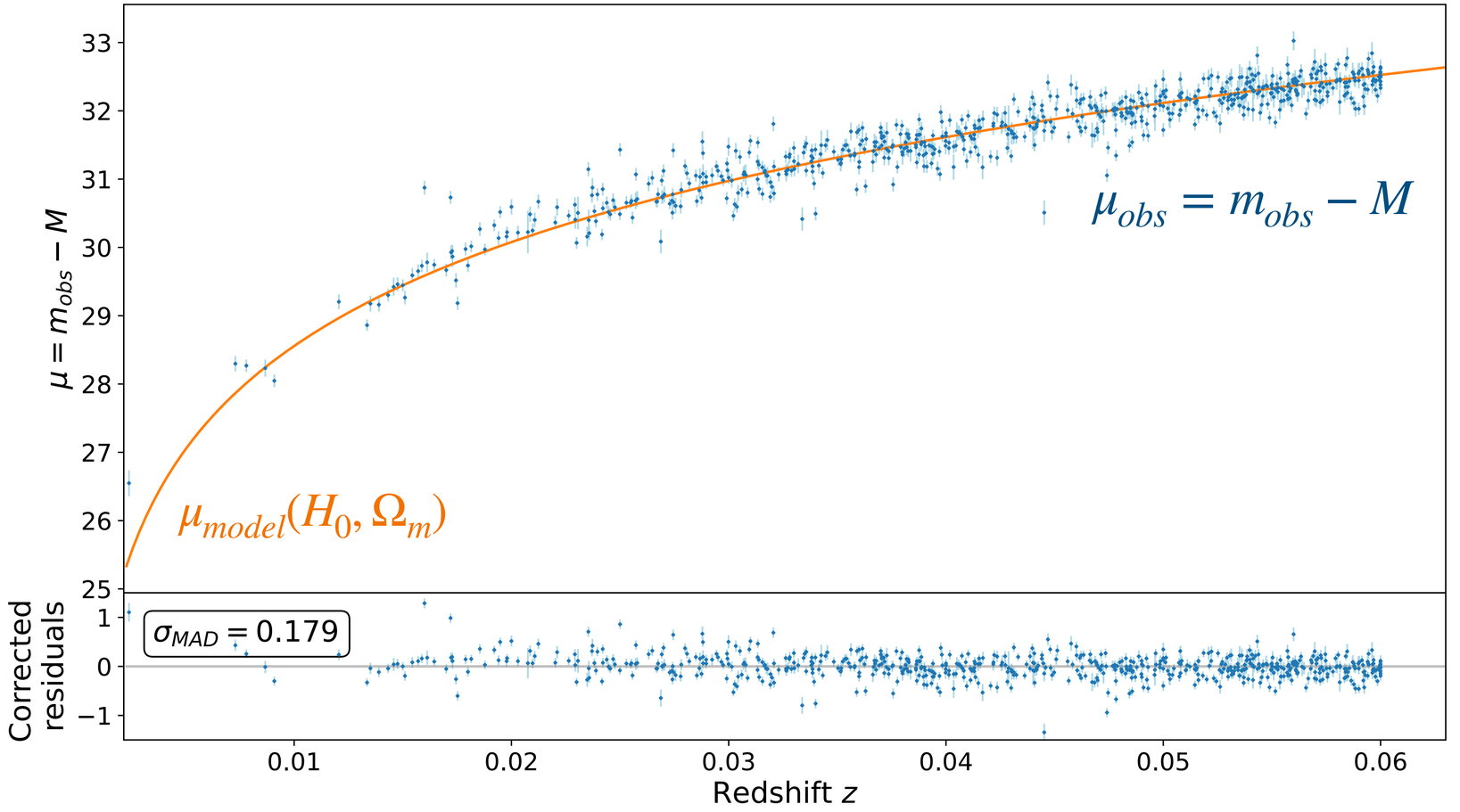
SNe standardisation with the ZTF DR2 volume limited sample

Supervisors : Mickaël Rigault, Mat Smith

Madeleine GINOLIN - 30th november 2022

Cosmology with SNe

Hubble diagram



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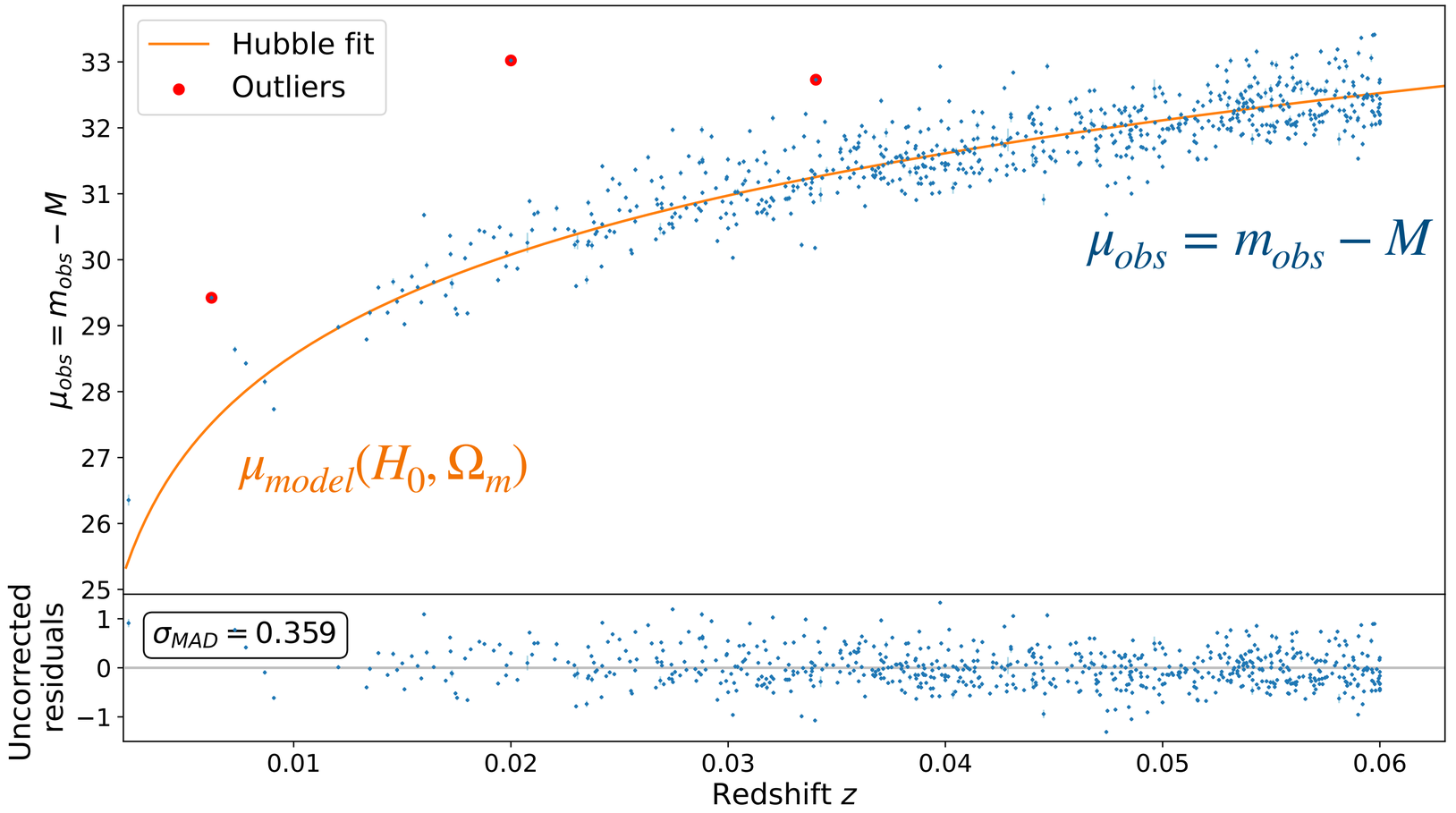
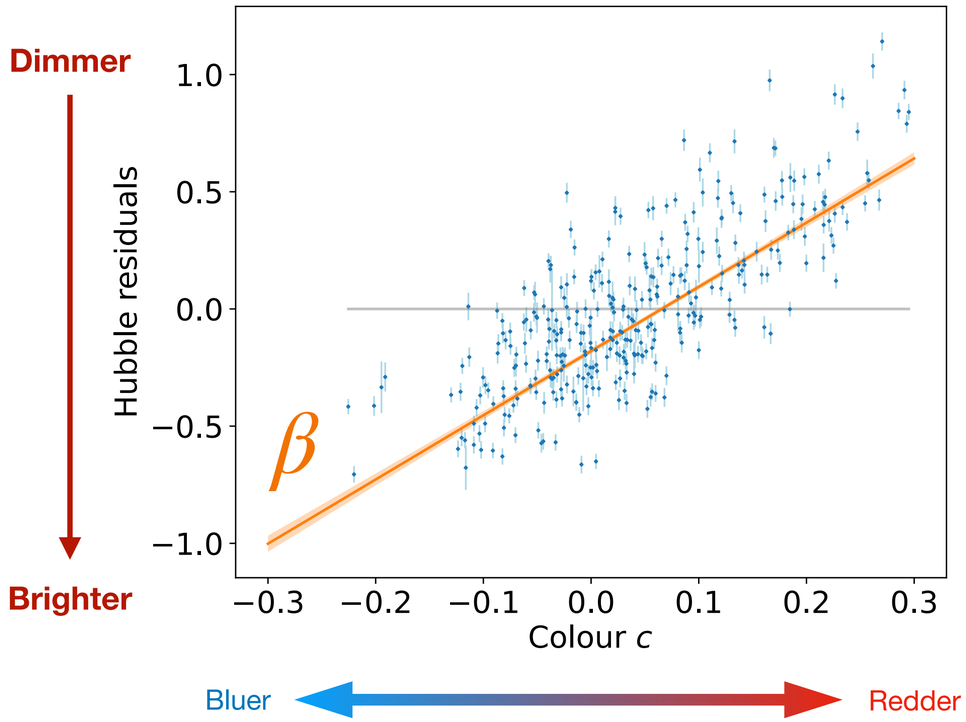
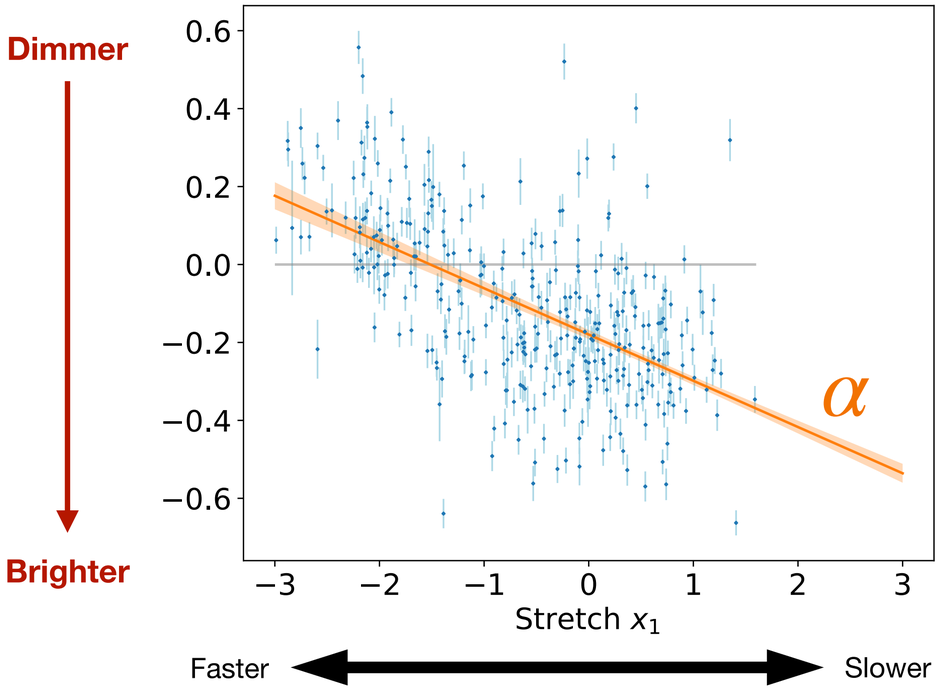


Cosmology with SNe

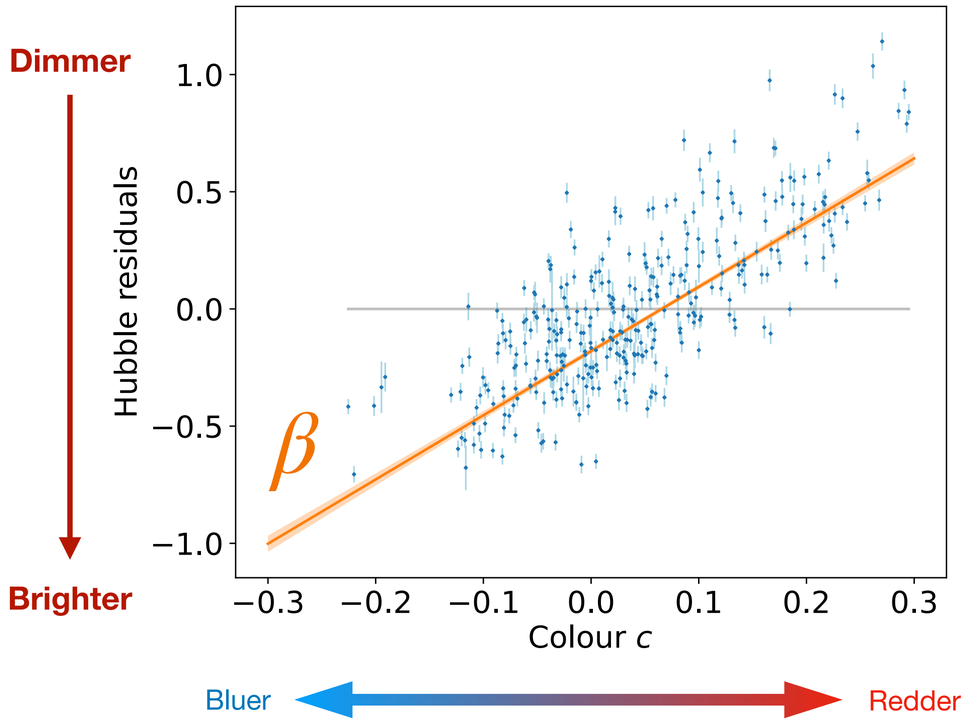
Supernovae standardisation

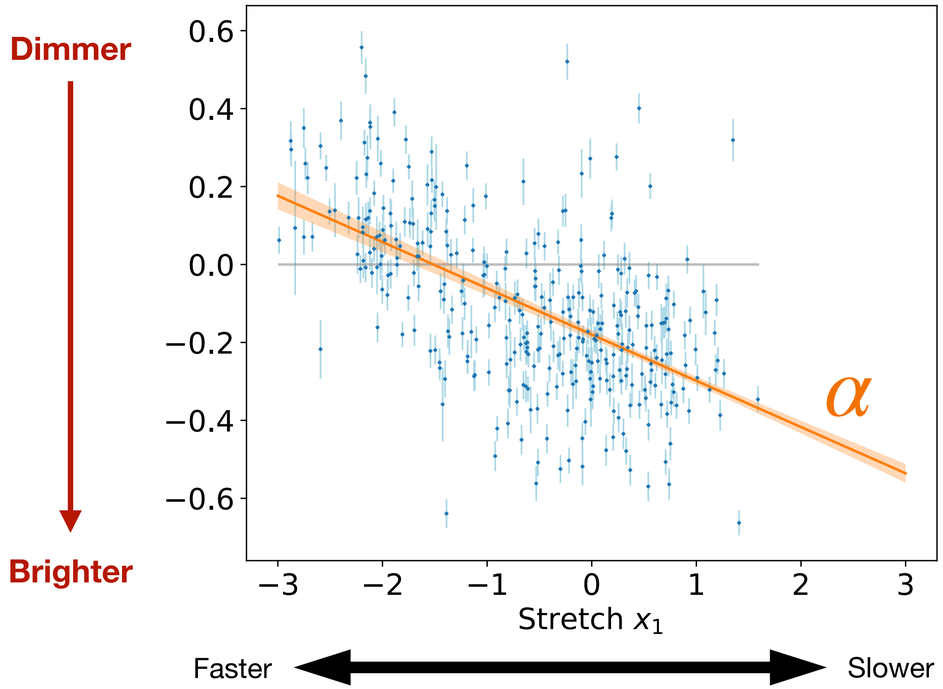




Cosmology with SNe

Supernovae standardisation



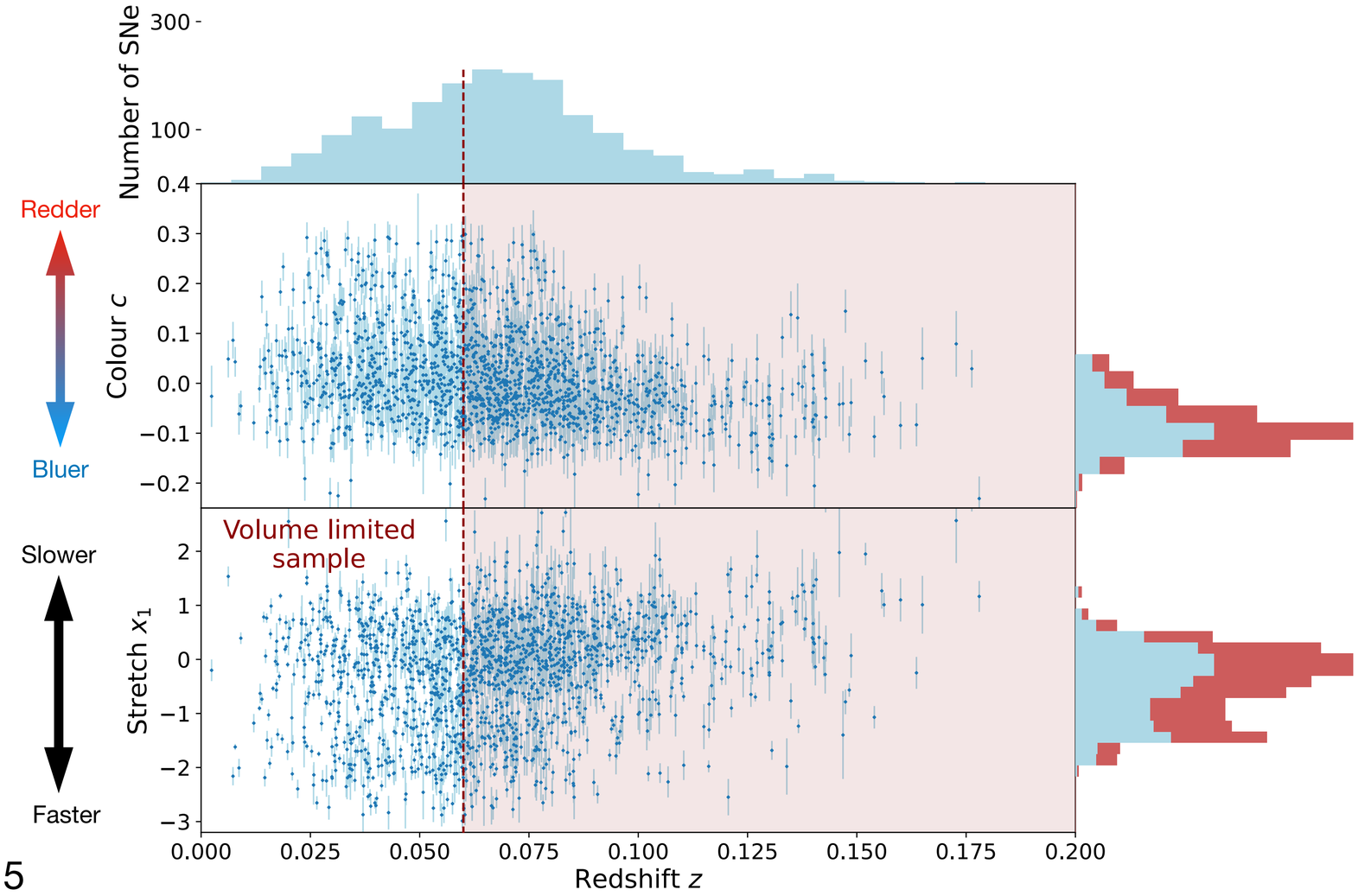


$$\mu_{model} + M = m_{obs} - \beta c + \alpha x_1$$

(Tripp 1998)

DR2

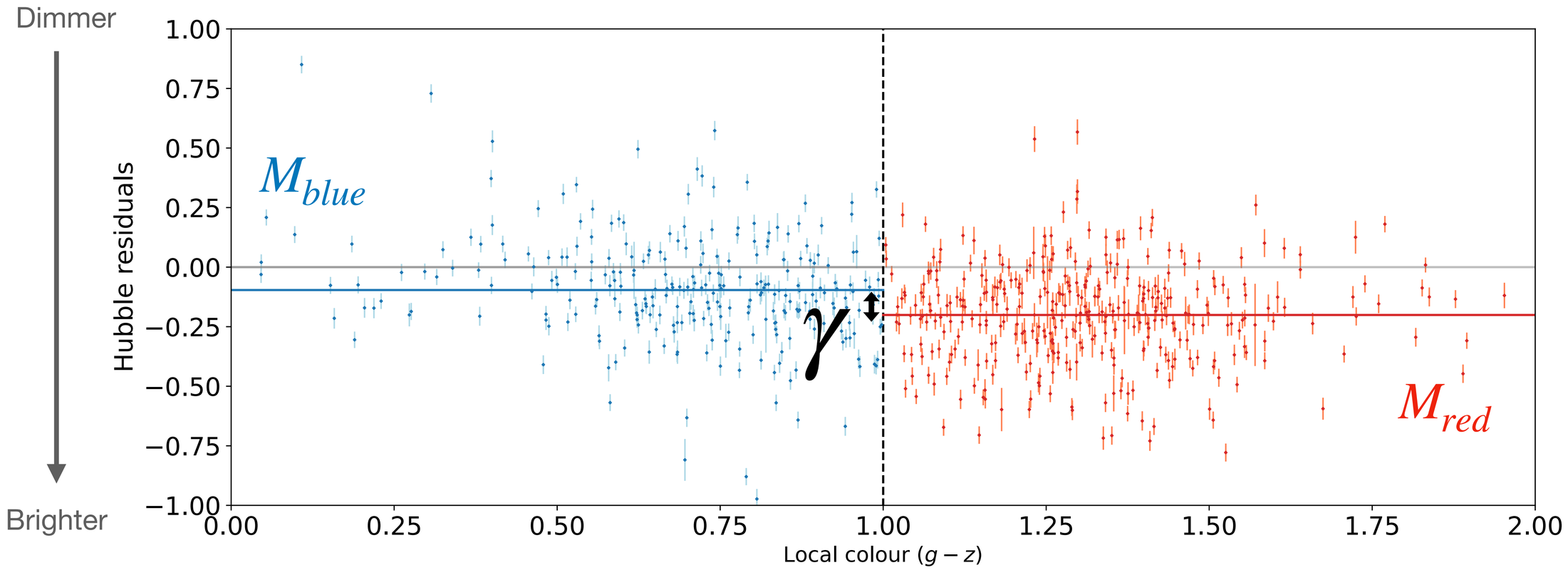
Volume limited sample



Sample	Size
Full DR2 sample	3740
Good light curve	2951
Redshift cut	1143
SALT fit probability	1138
Color cut (values and errors)	947
Stretch cut (values and errors)	912
TypingApp classifications	691

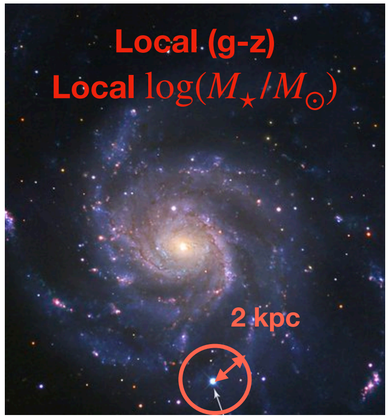
Standardisation steps

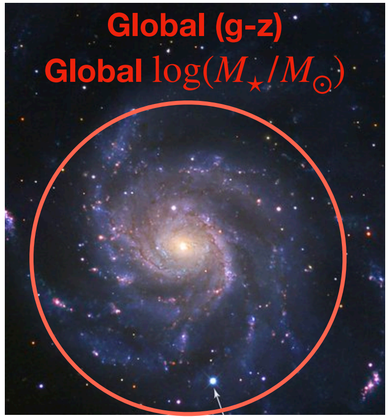
$$\Delta m = \beta c - \alpha x_1 + p\gamma$$



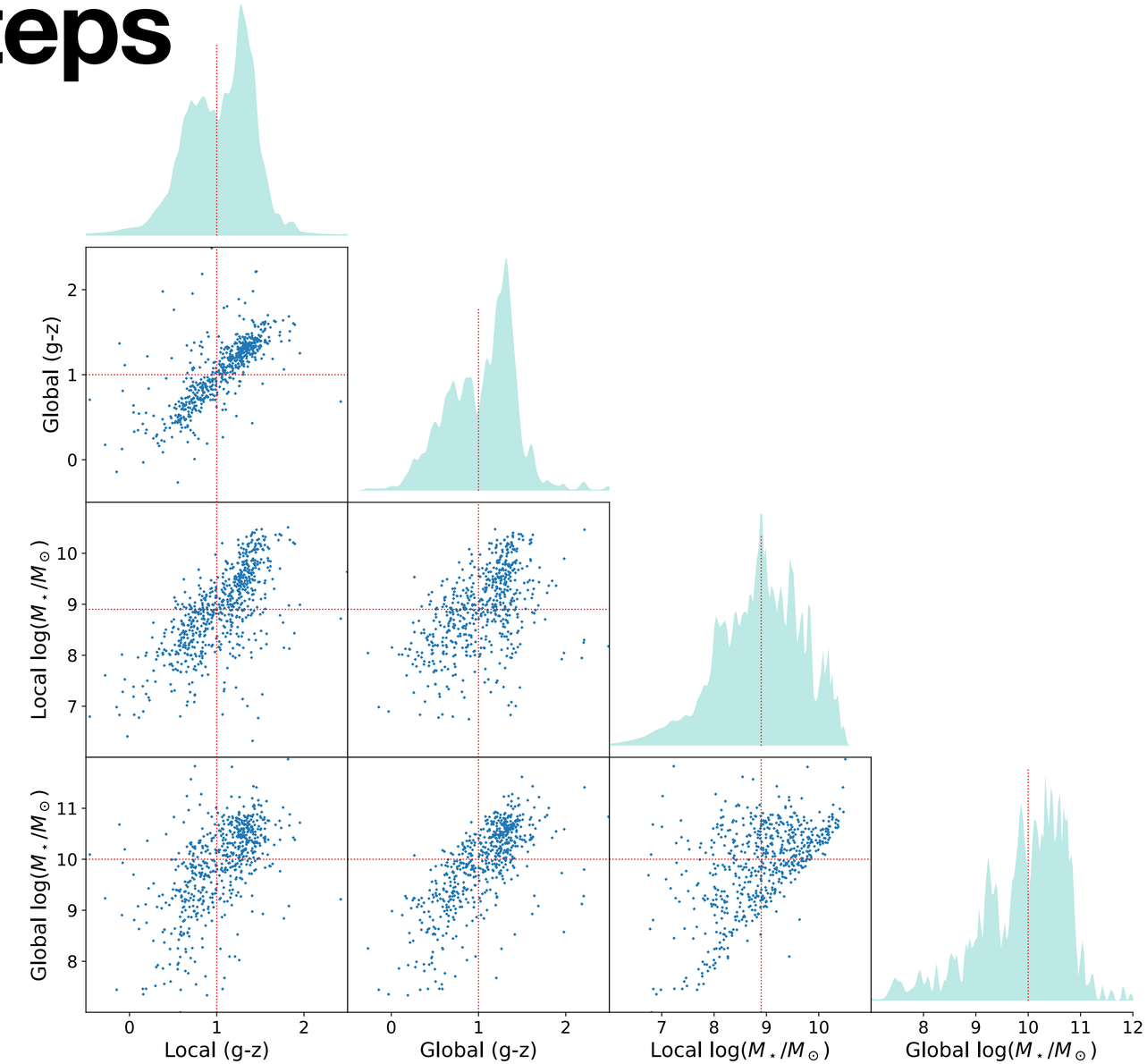
Standardisation steps

Environmental proxies





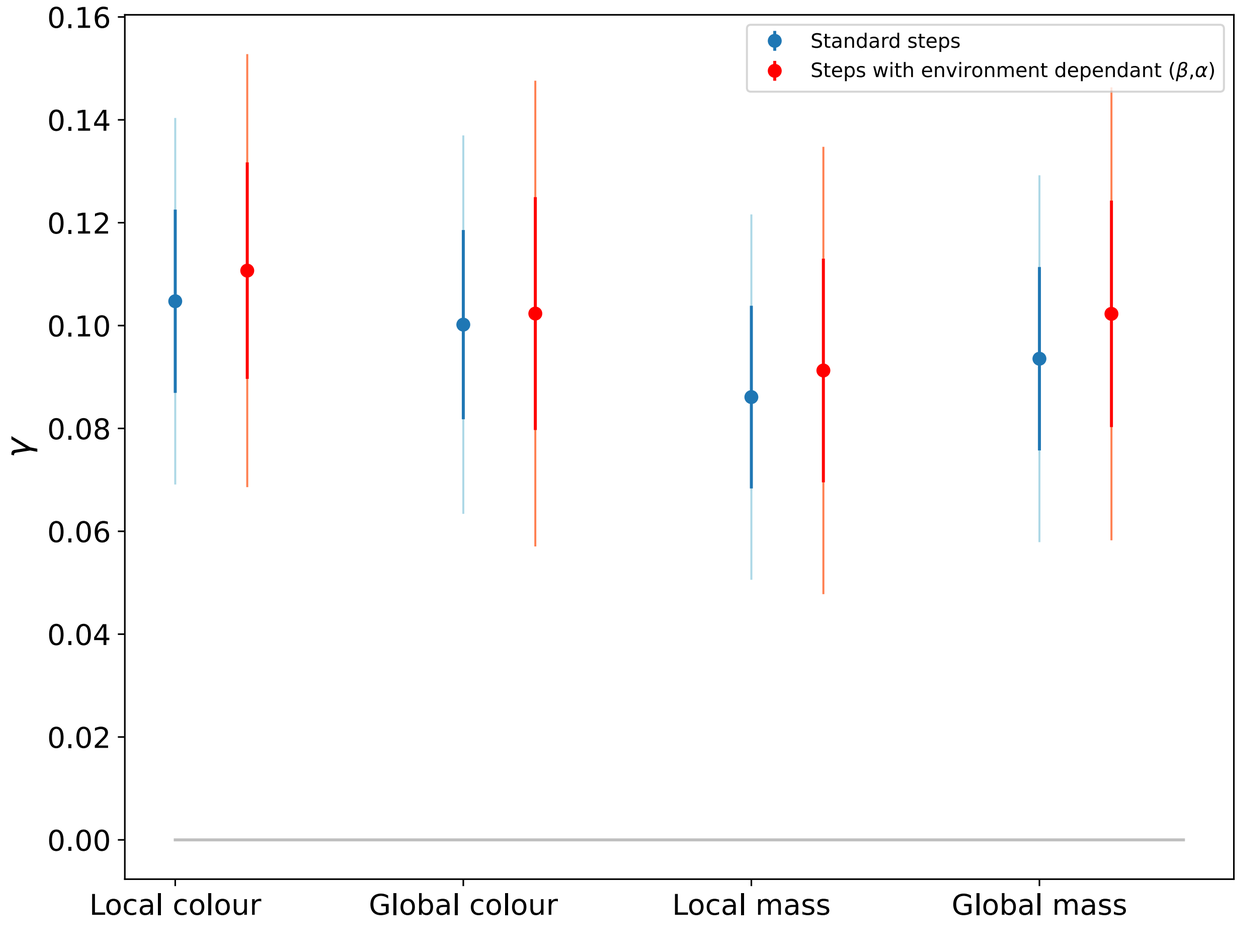
Credits: B.J. Fulton/
LCOGT/Caltech



Standardisation steps

Comparison across tracers

$$\Delta m = \beta c - \alpha x_1 + p\gamma$$



Standardisation steps

$$\Delta m = \beta c - \alpha x_1 + p\gamma$$

A dust effect?

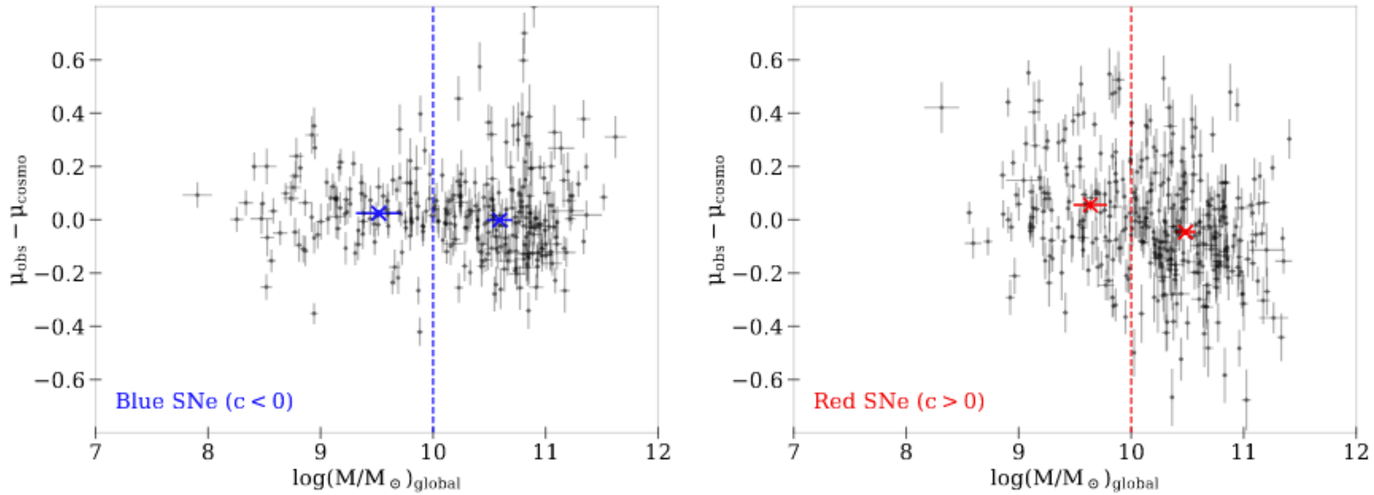


Table 3. Subsample Hubble residual steps when splitting the sample based on c using a BBC1D correction.

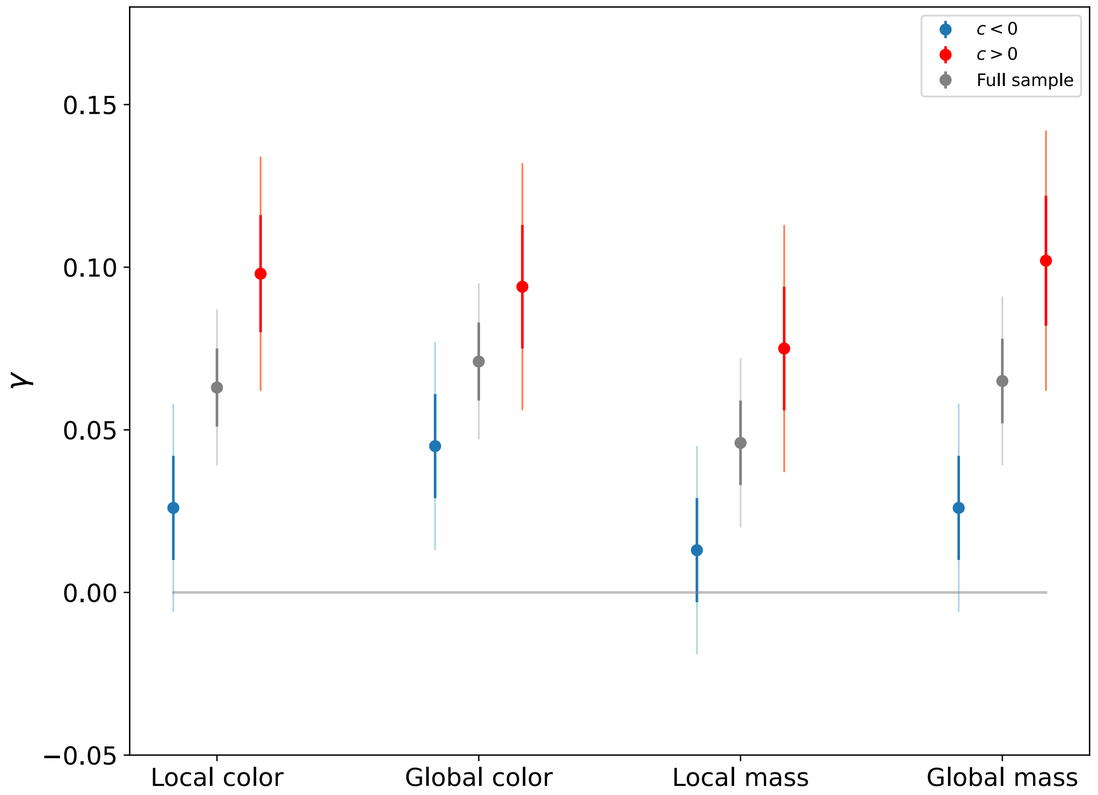
Property		$c < 0$ Hubble Residual Step		$c > 0$ Hubble Residual Step		
Name	Division Point	Magnitude	Sig. (σ)[b]	Magnitude	Sig. (σ)	Difference (σ)[c]
Number of Supernovae		306		369		
Global Mass[a]	10.0	0.026 ± 0.016	1.6	0.102 ± 0.020	5.0	3.0
Local Mass	9.4	0.013 ± 0.016	0.8	0.075 ± 0.019	4.0	2.5
Global U-R	1.0	0.045 ± 0.016	2.9	0.094 ± 0.019	5.1	2.0
Local U-R	1.1	0.026 ± 0.016	1.6	0.098 ± 0.018	5.3	3.0

Kelsey et al (2022)

Standardisation steps

A dust effect?

$$\Delta m = \beta c - \alpha x_1 + p\gamma$$



Kelsey et al (2022)

Standardisation steps

A dust effect?

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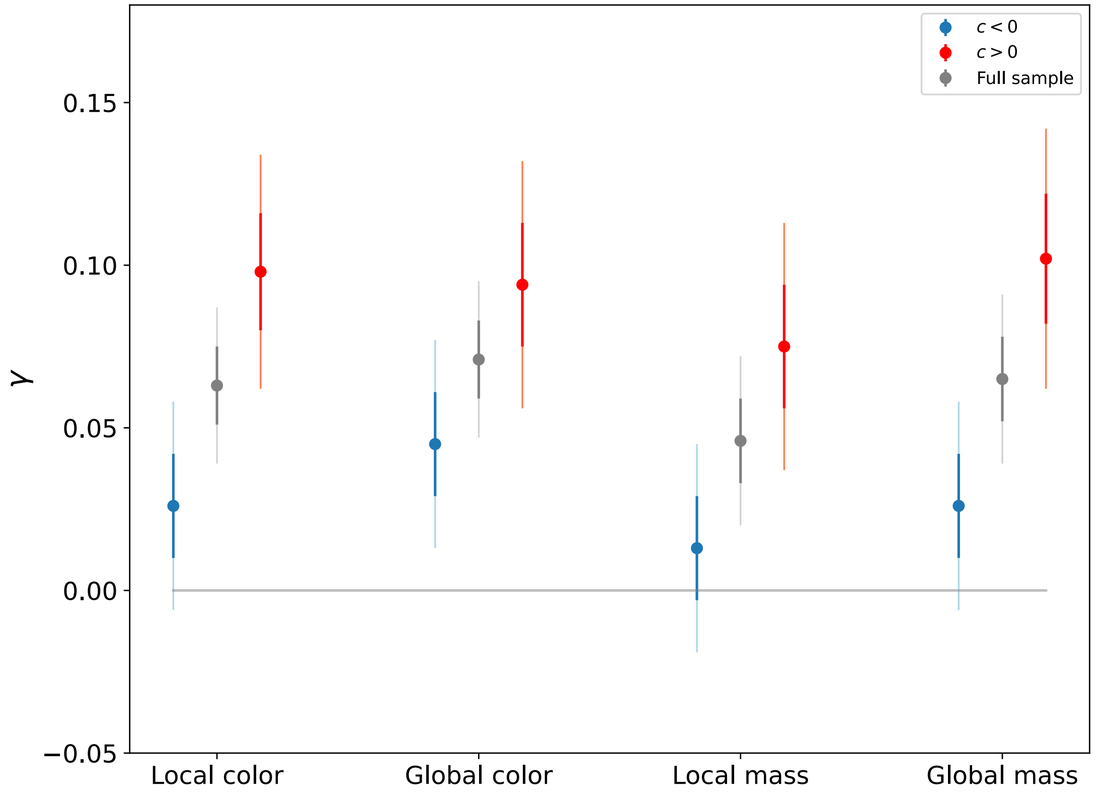
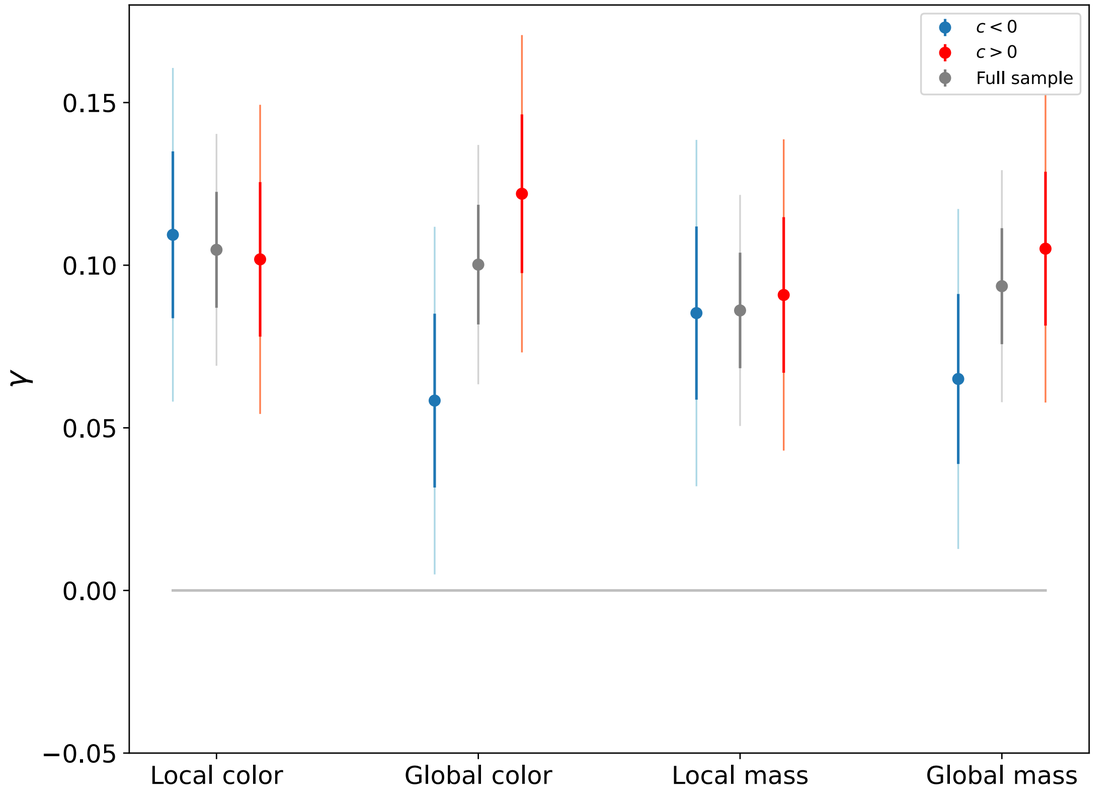


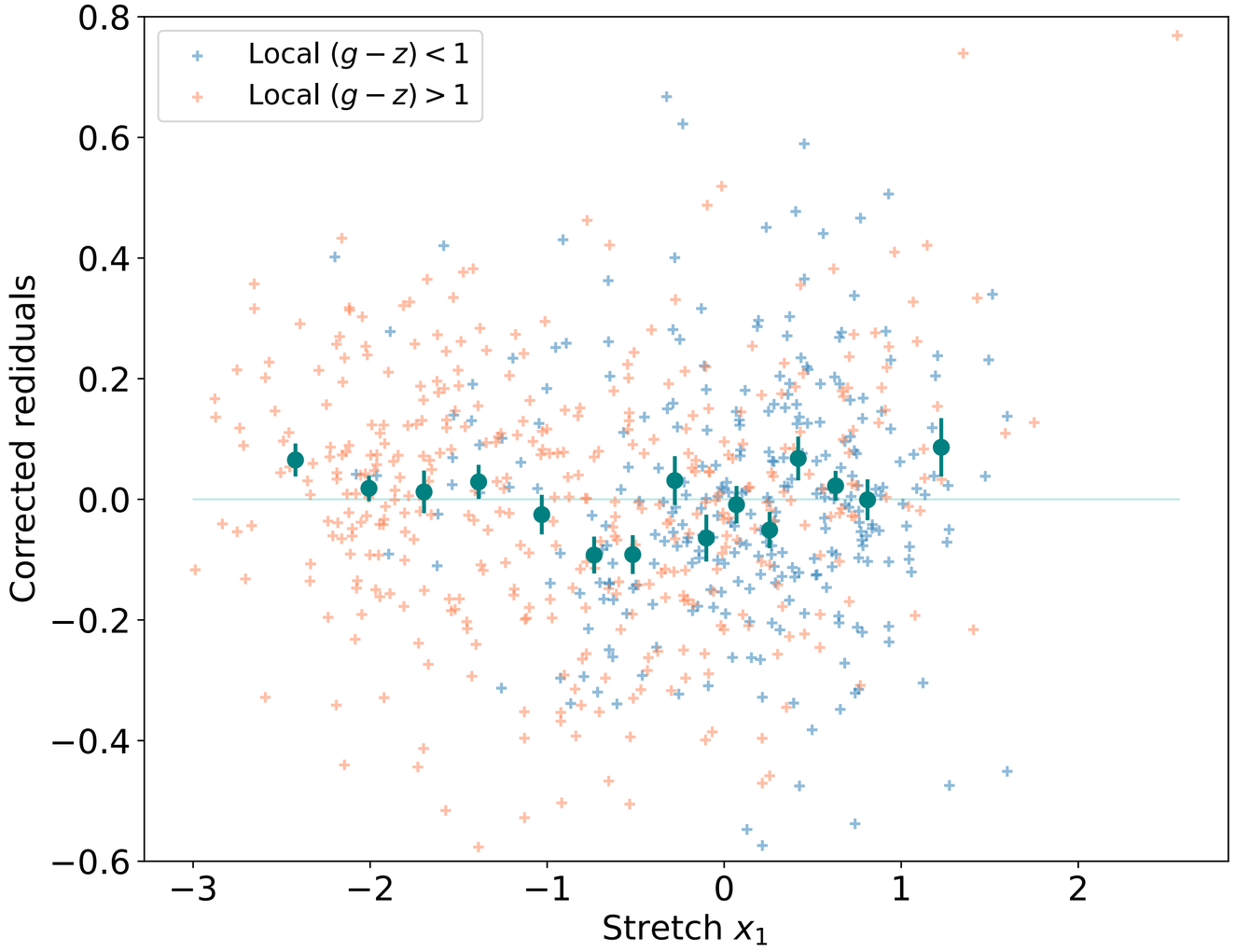


Kelsey et al (2022)

Stretch standardisation

Non linear standardisation

$$\Delta m = \beta c - \alpha x_1 + p\gamma$$



Stretch standardisation

$$\Delta m = \beta c - \alpha x_1 + p\gamma$$

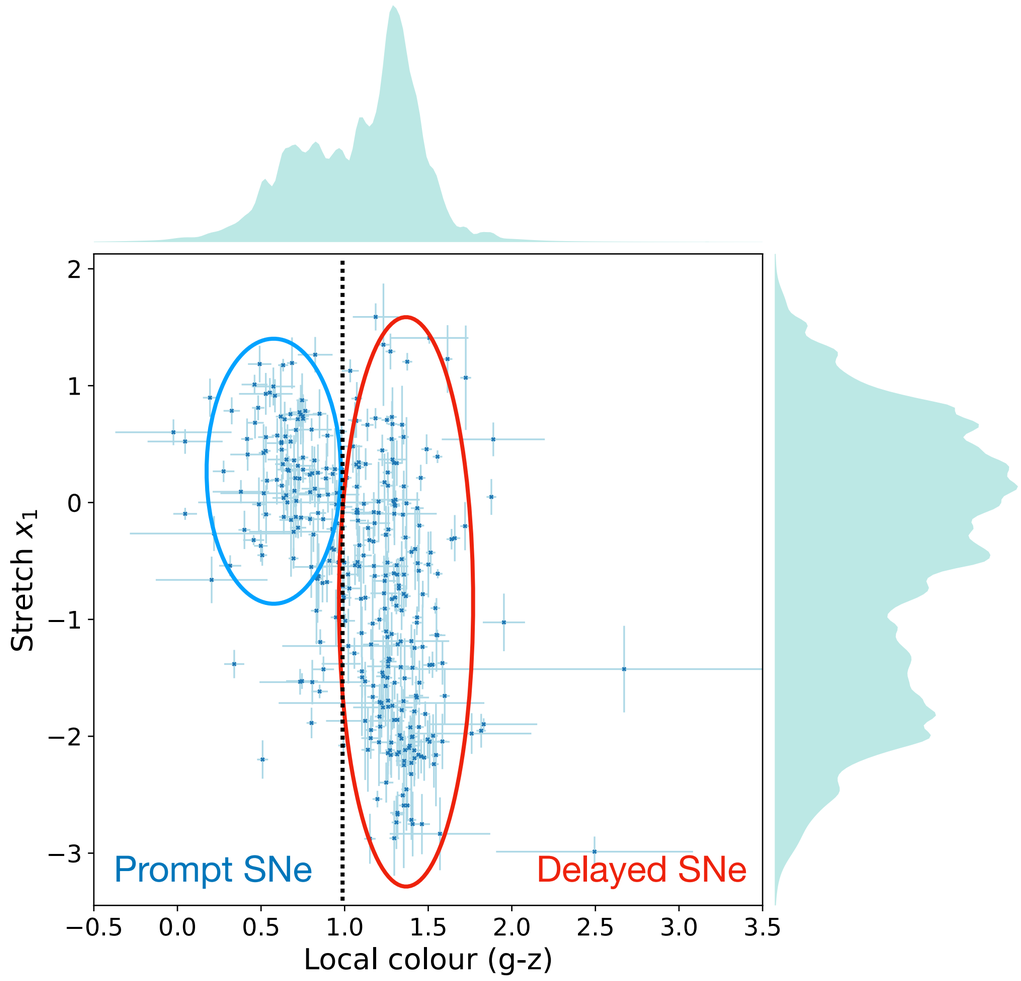
Model comparison

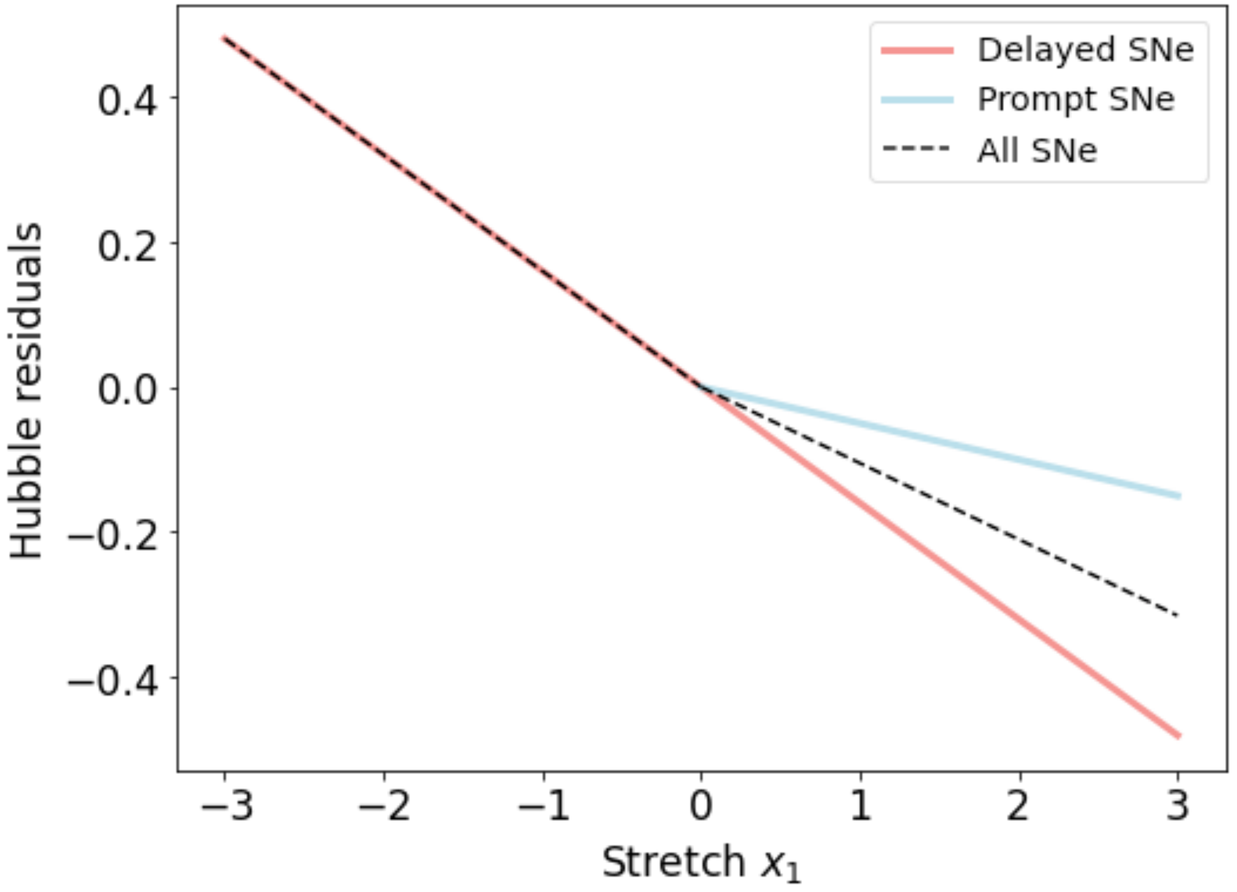
Model	Number of parameters	AIC	Delta AIC (In respect w/ the best model)
Single line	5	-53.6	-36.8
Broken line with fixed cut in stretch	6	-74.7	-15.7
Broken line with variable cut	7	-76.2	-14.3
Polynomial	6	-90.4	0

Stretch standardisation

Is it an age effect?

$$\Delta m = \beta c - \alpha x_1 + p\gamma$$





Rigault et al (2020), Nicolas et al (2021)

Stretch standardisation

Is it an age effect?

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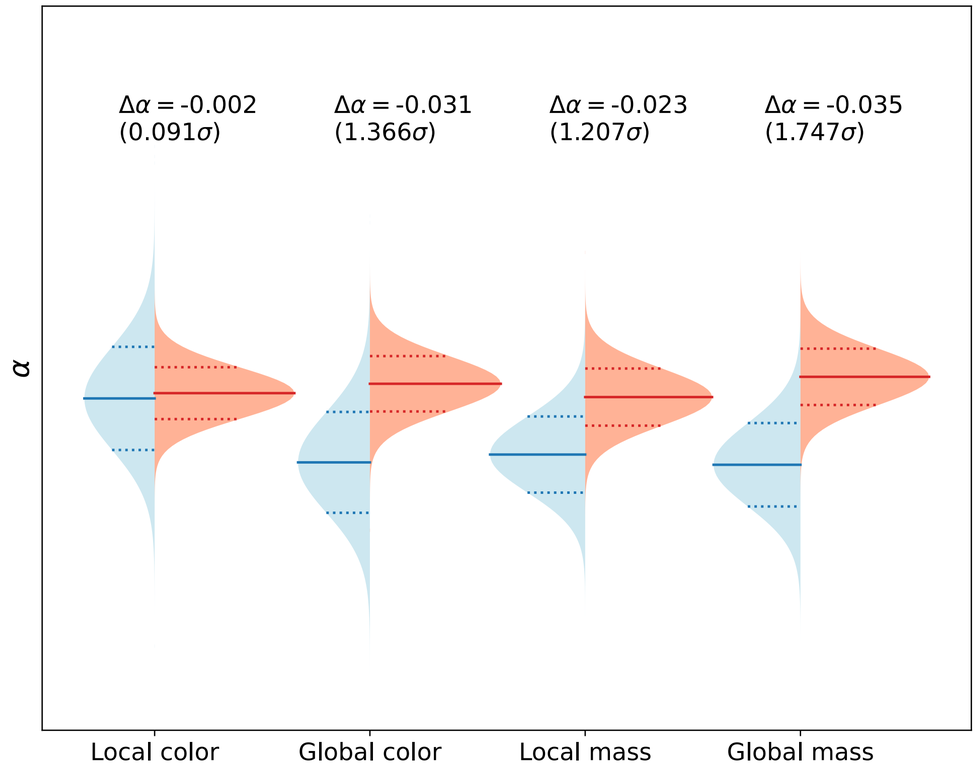
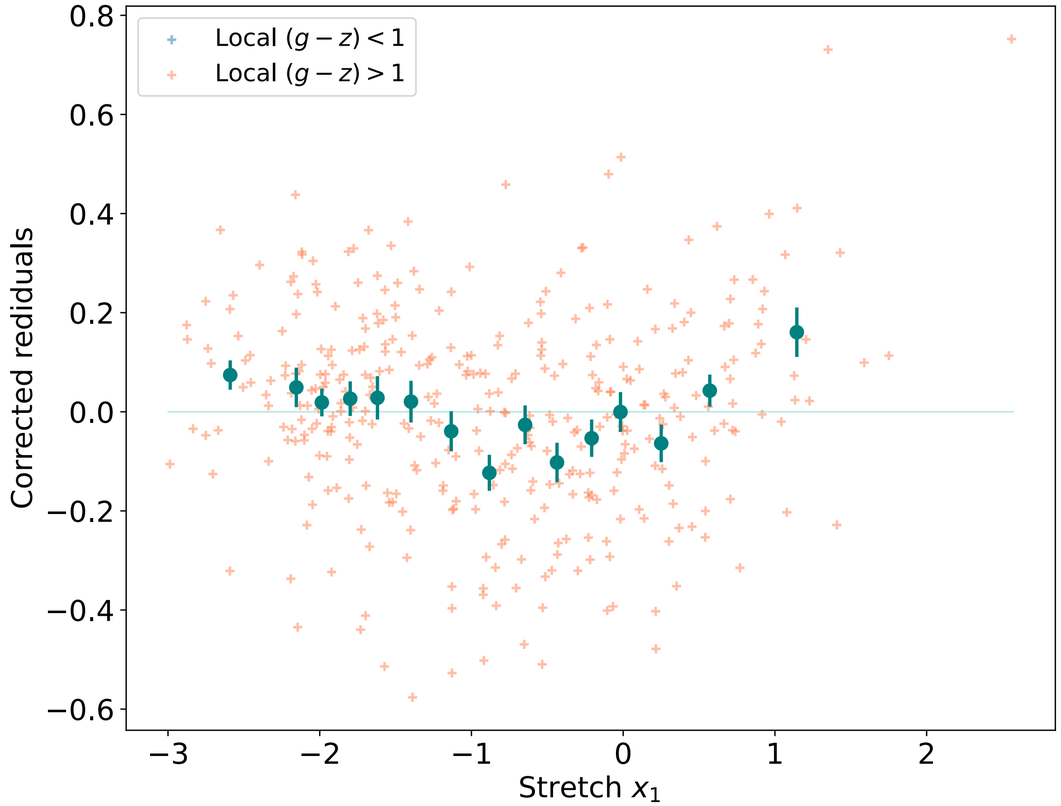
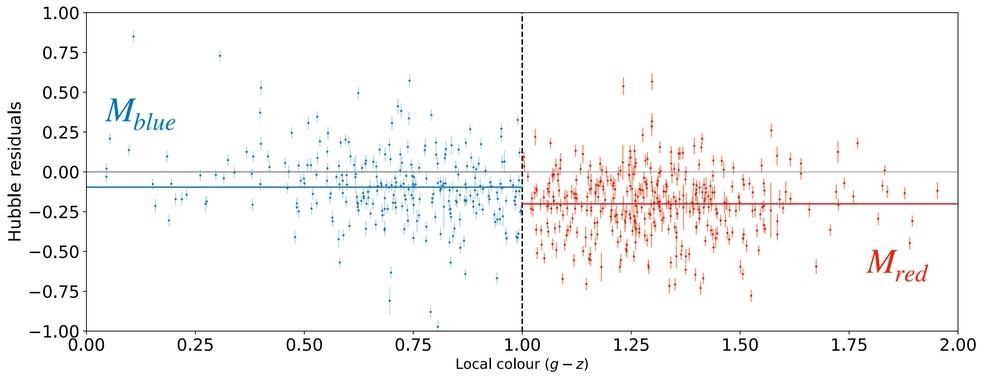


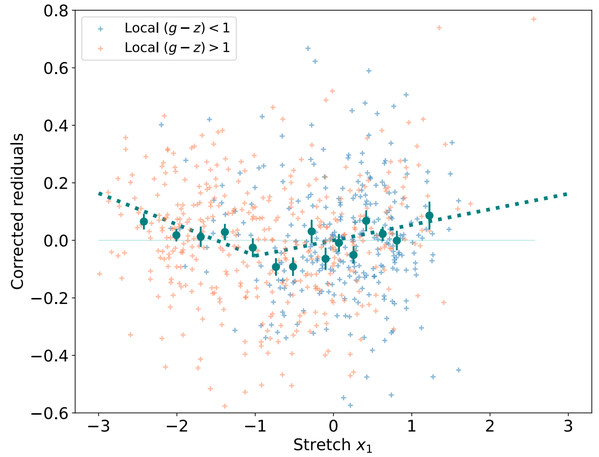


Conclusion

ZTF DR2

Standardisation dependency on SNe parameters/environment





Future SNe surveys