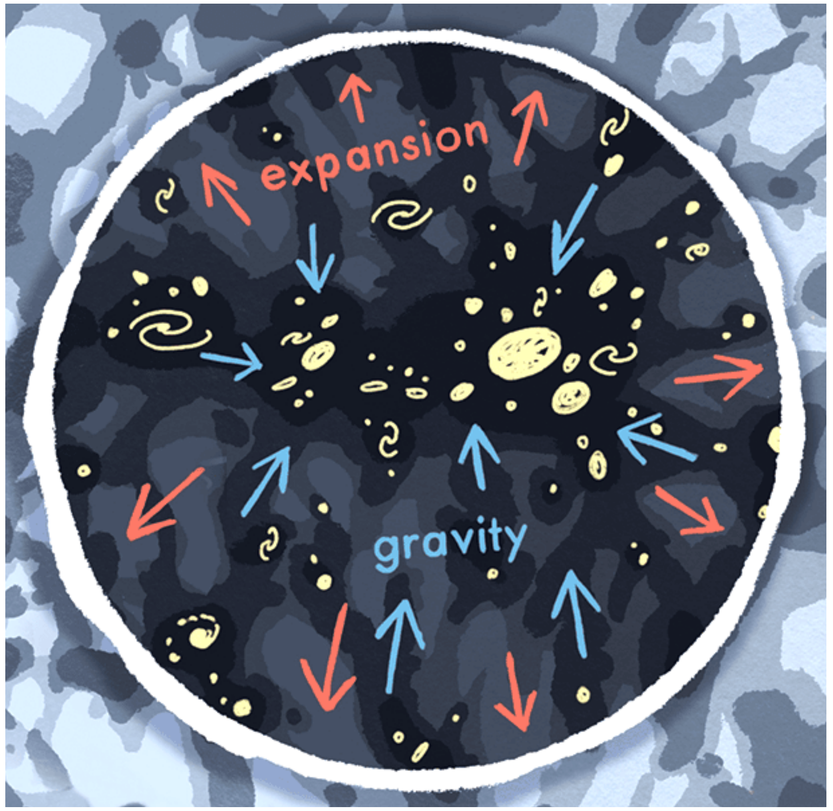
$f\sigma_8$ measurement with the type Ia Supernovae from the Zwicky Transient Facility DR2.5

WG Dark Energy 2025 - Montpellier

Introduction

$f\sigma_8$



Credits: Jessie Muir

Growth rate of linear perturbations

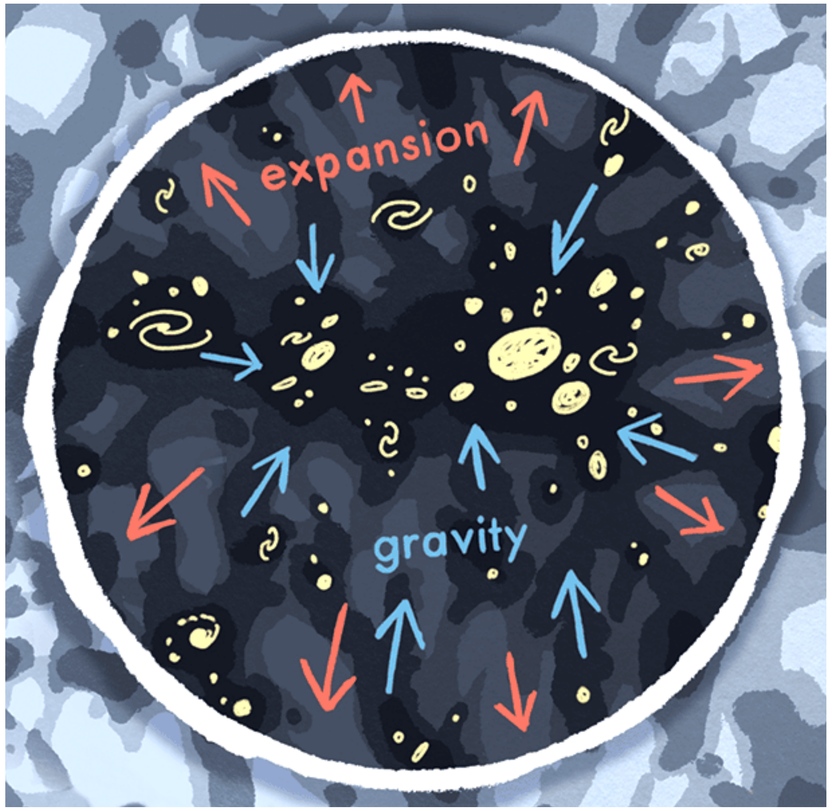
$$\nabla . \vec{v}(\vec{r}) \propto f\sigma_8$$

Velocity field

Amplitude of the matter fluctuations

Introduction

$f\sigma_8$



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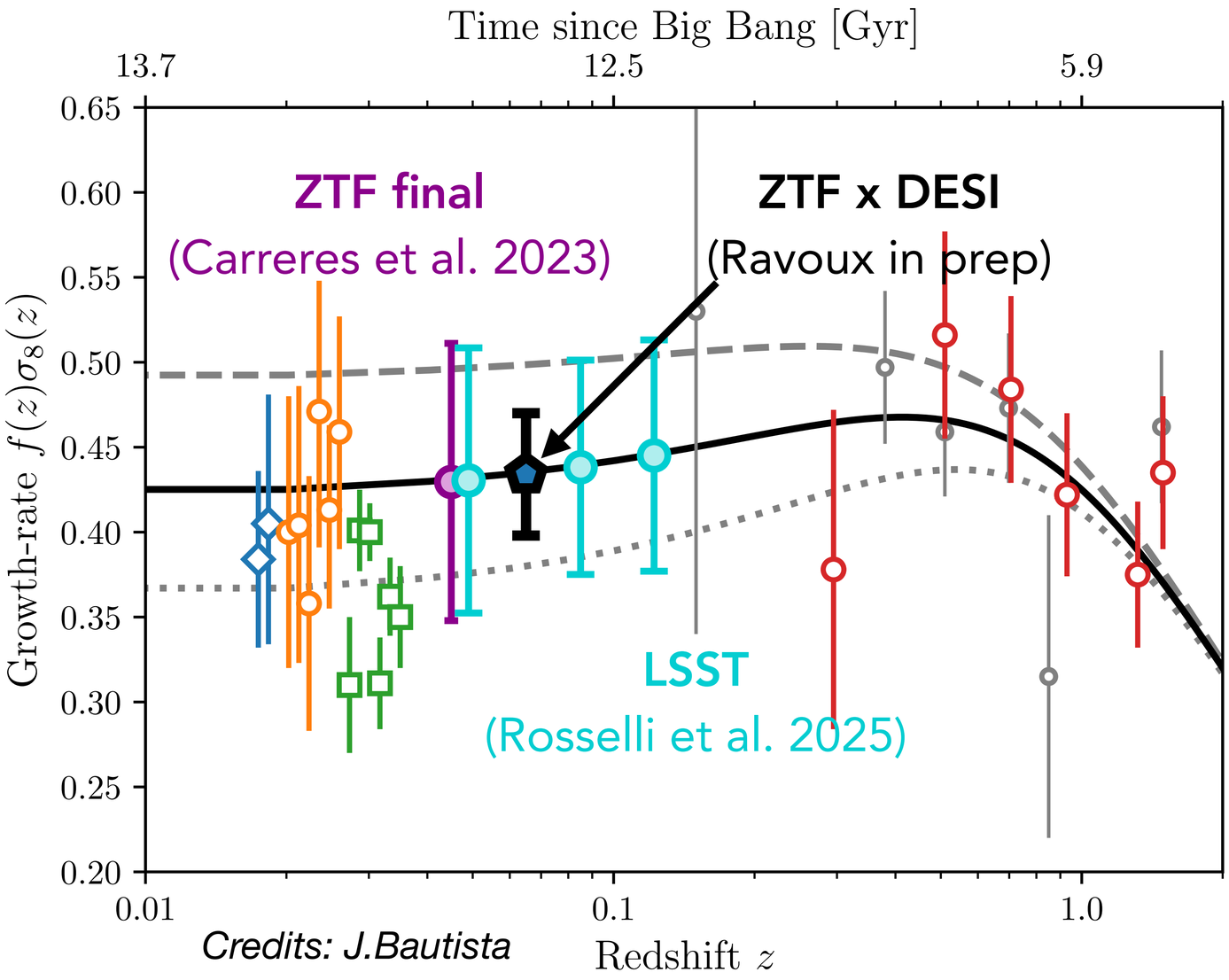


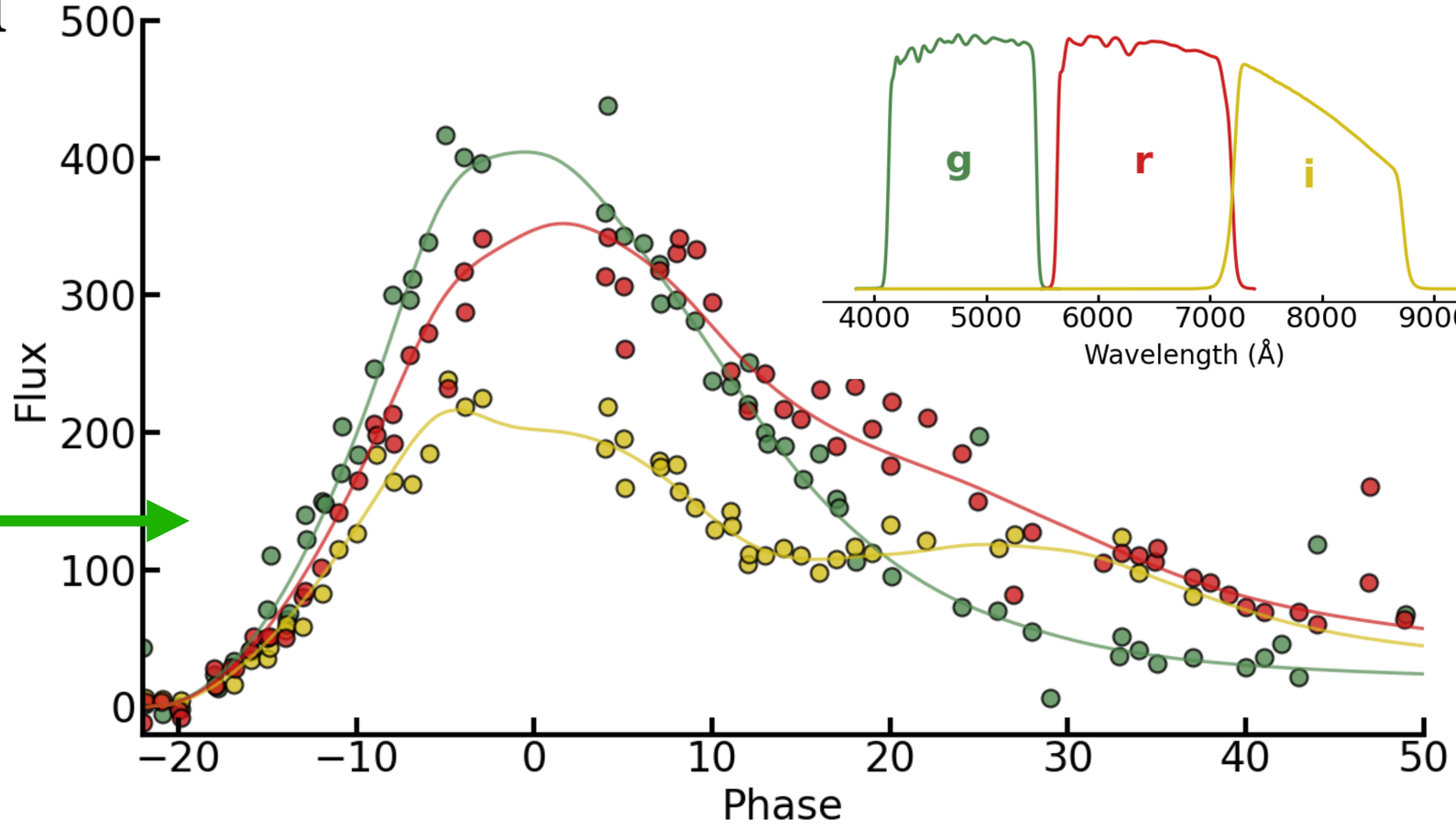
Credits: J.Bautista

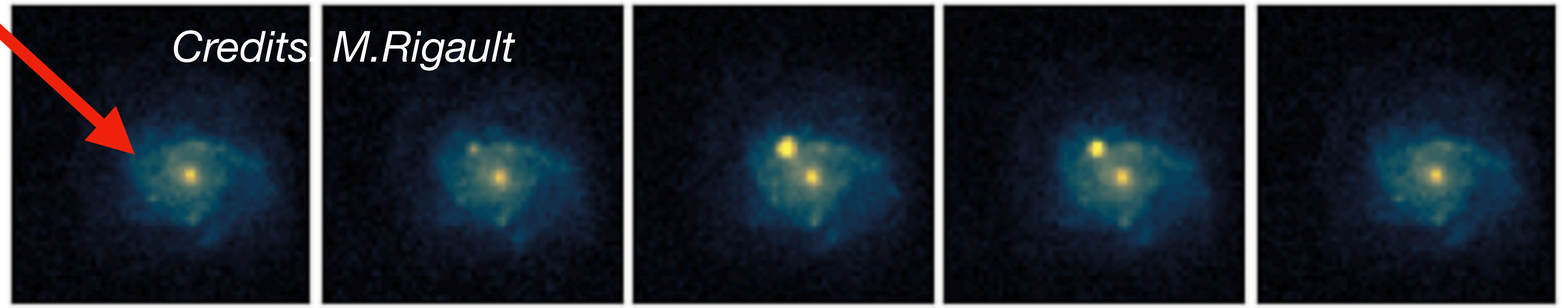
Introduction

SNIa

Photometric magnitude

Spectroscopic z

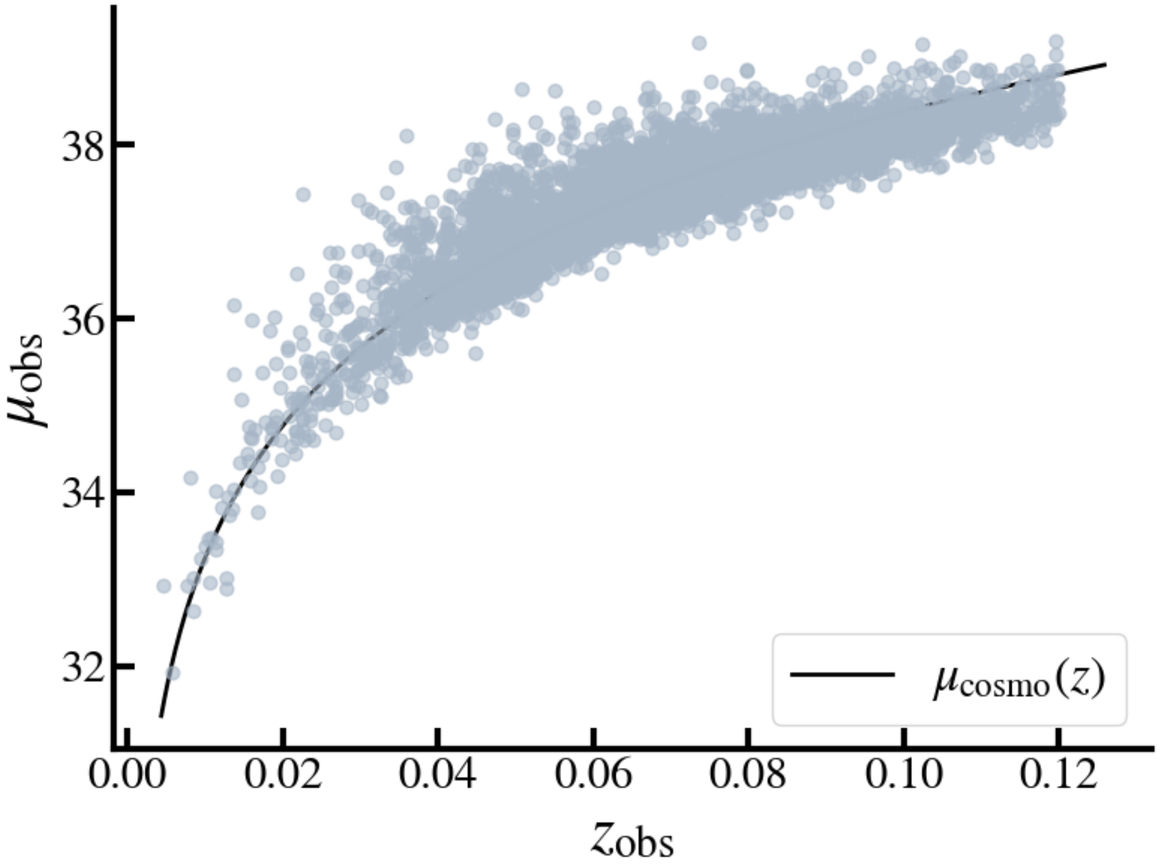


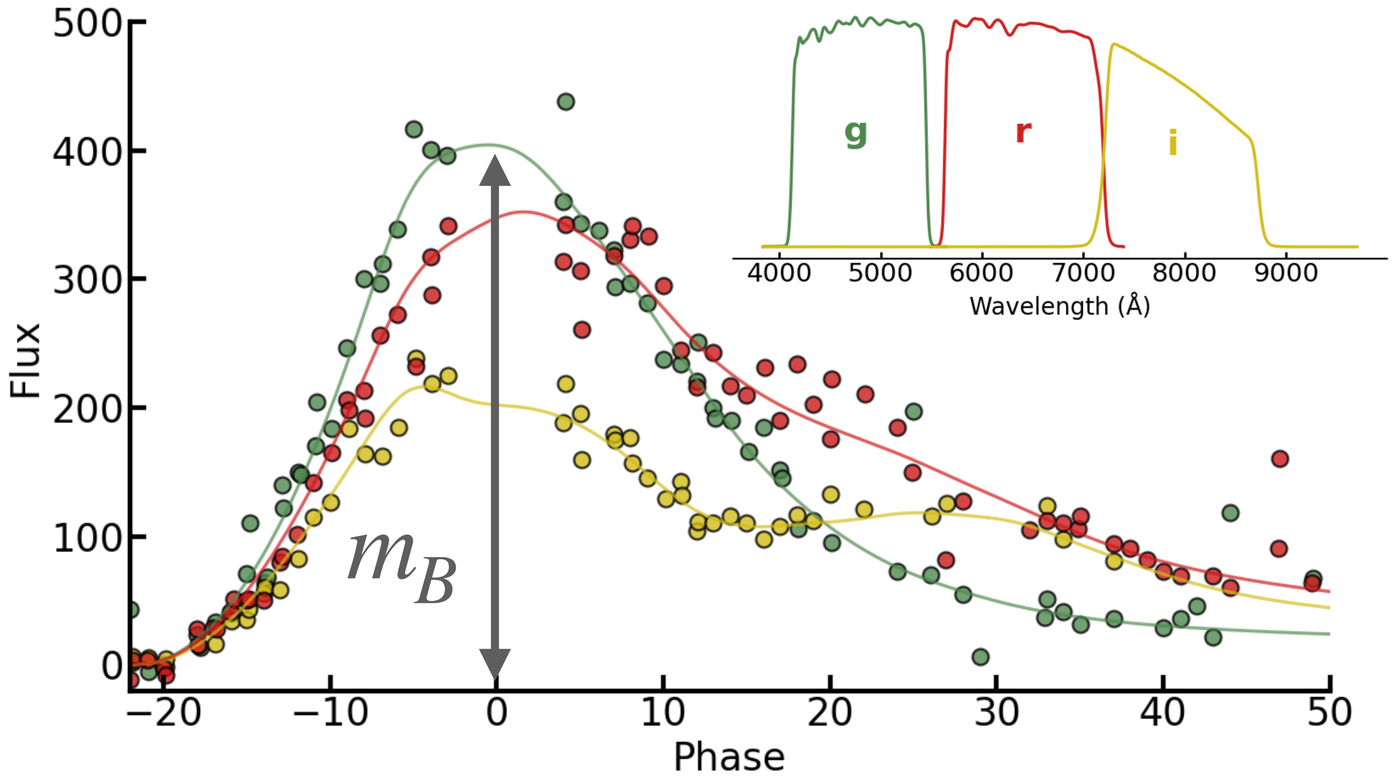


Introduction

SNIa

$$\mu_{obs} = M_0 + m_B - \beta c + \alpha x_1$$





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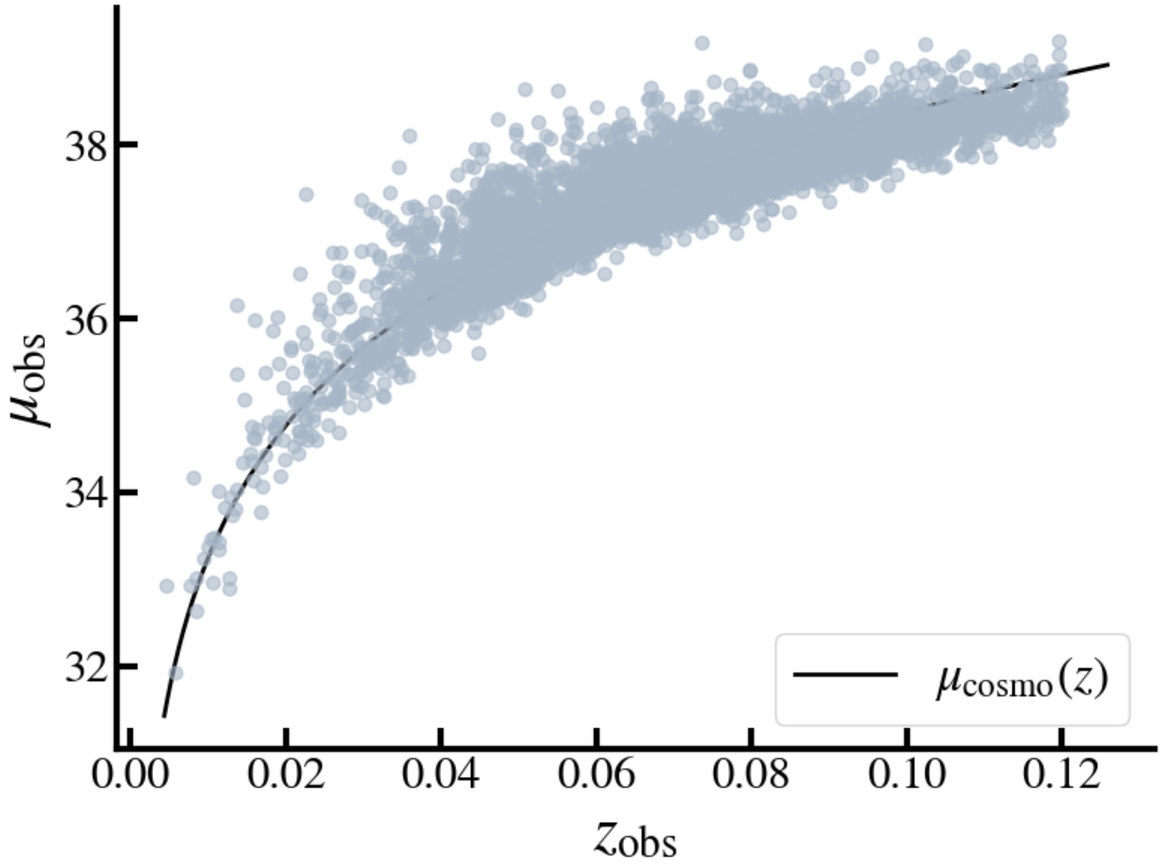

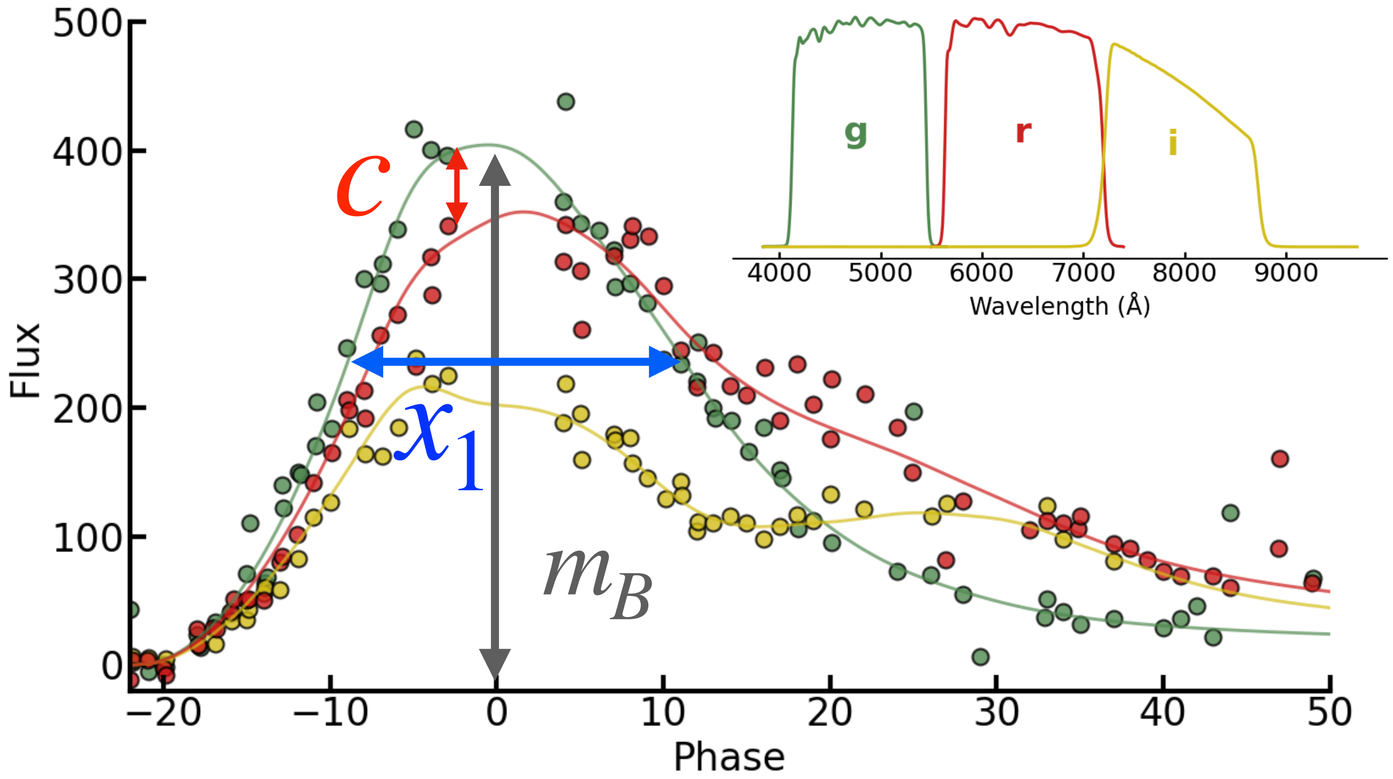

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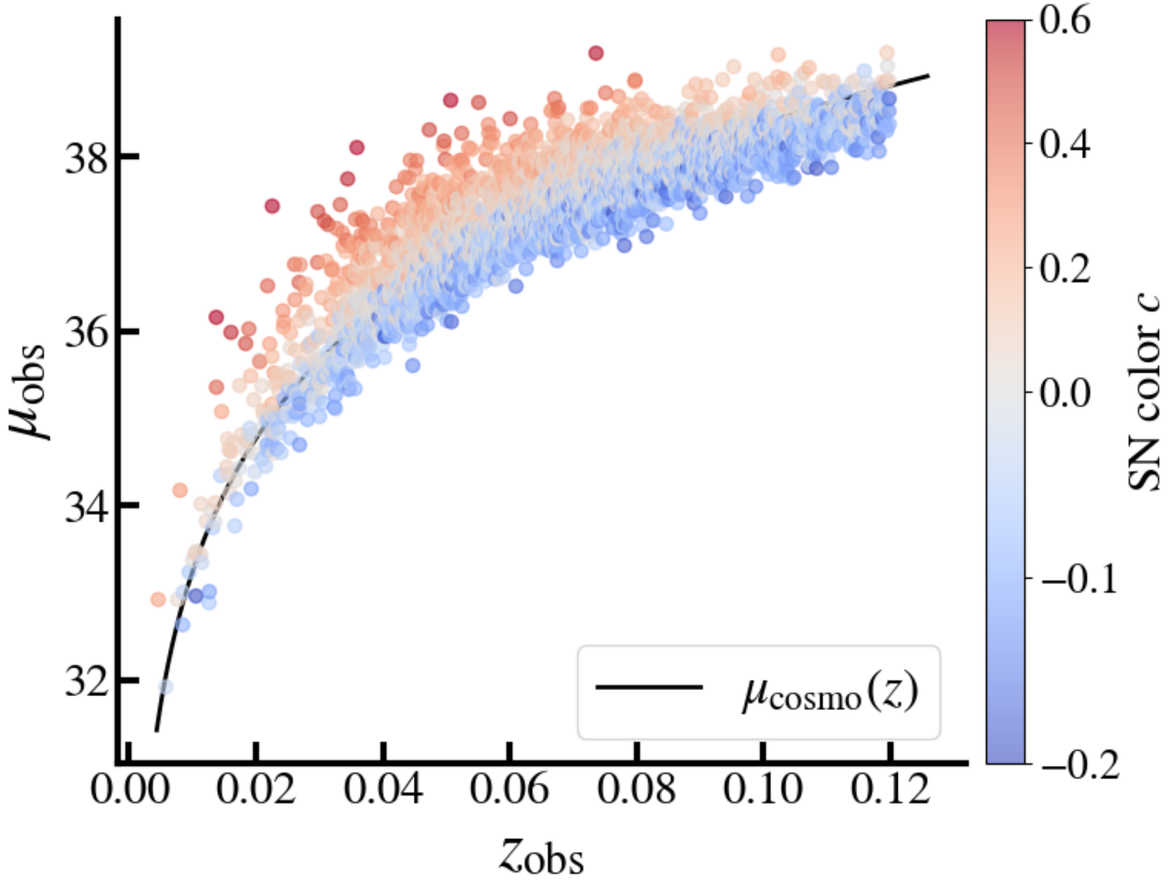

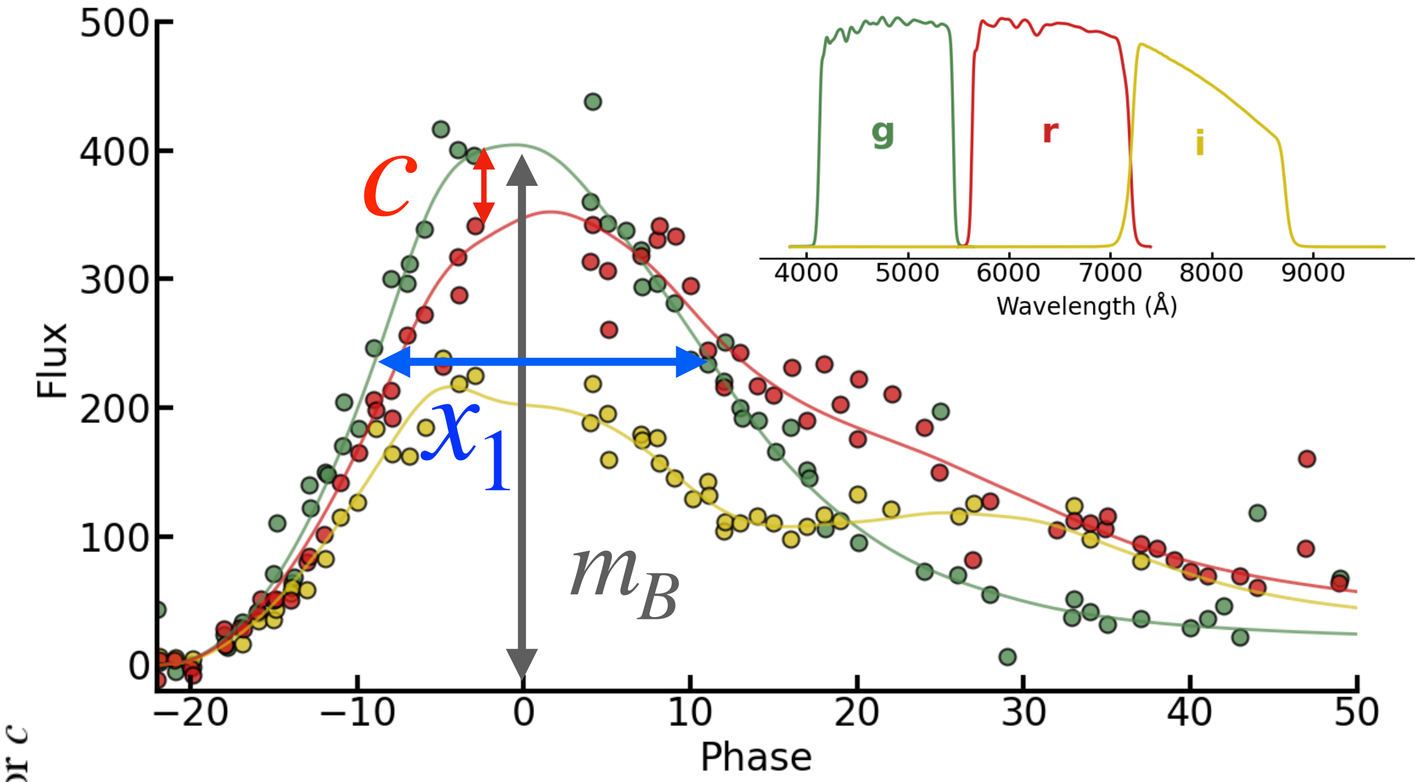

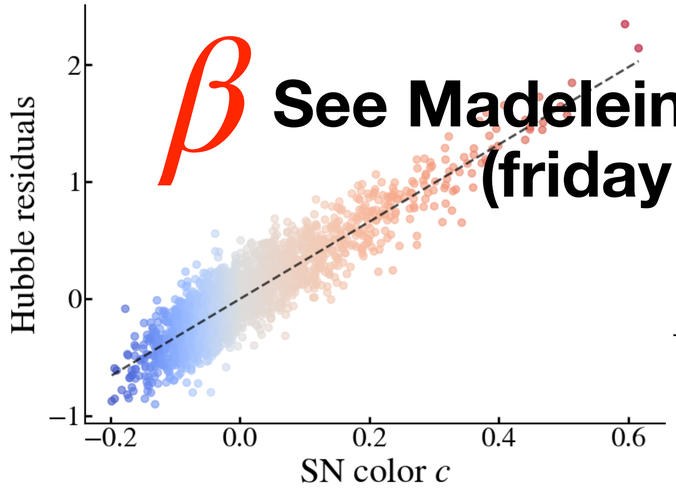

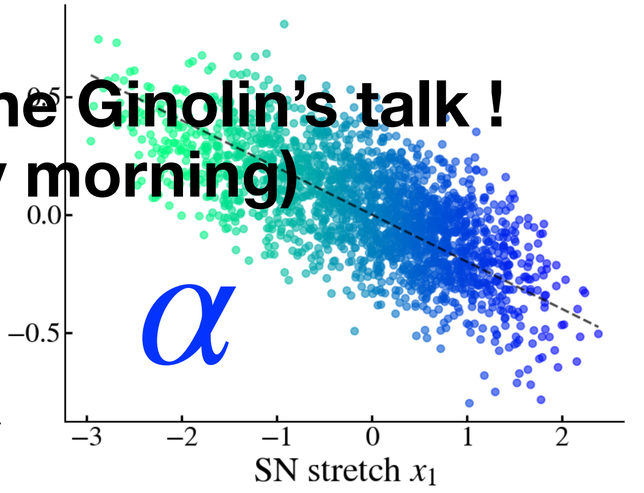

See Madeleine Ginolin's talk ! (friday morning)

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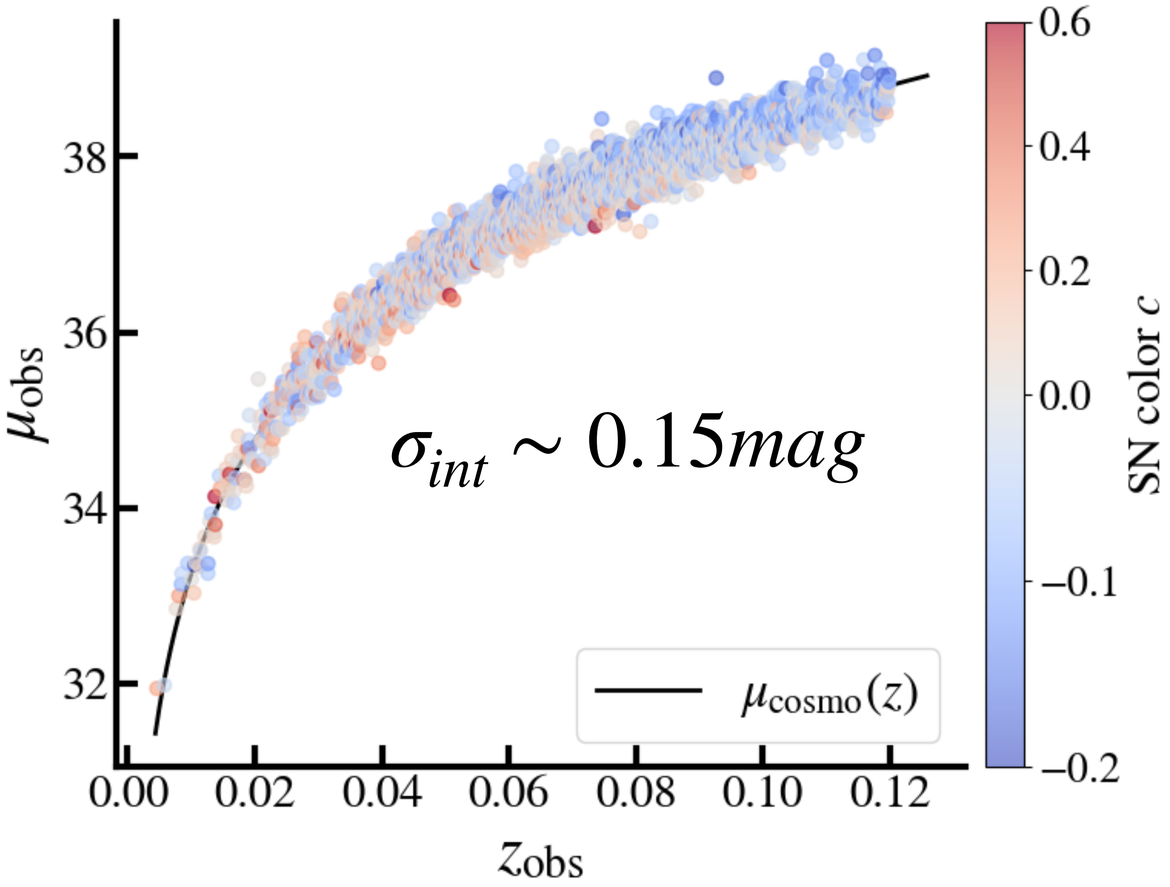
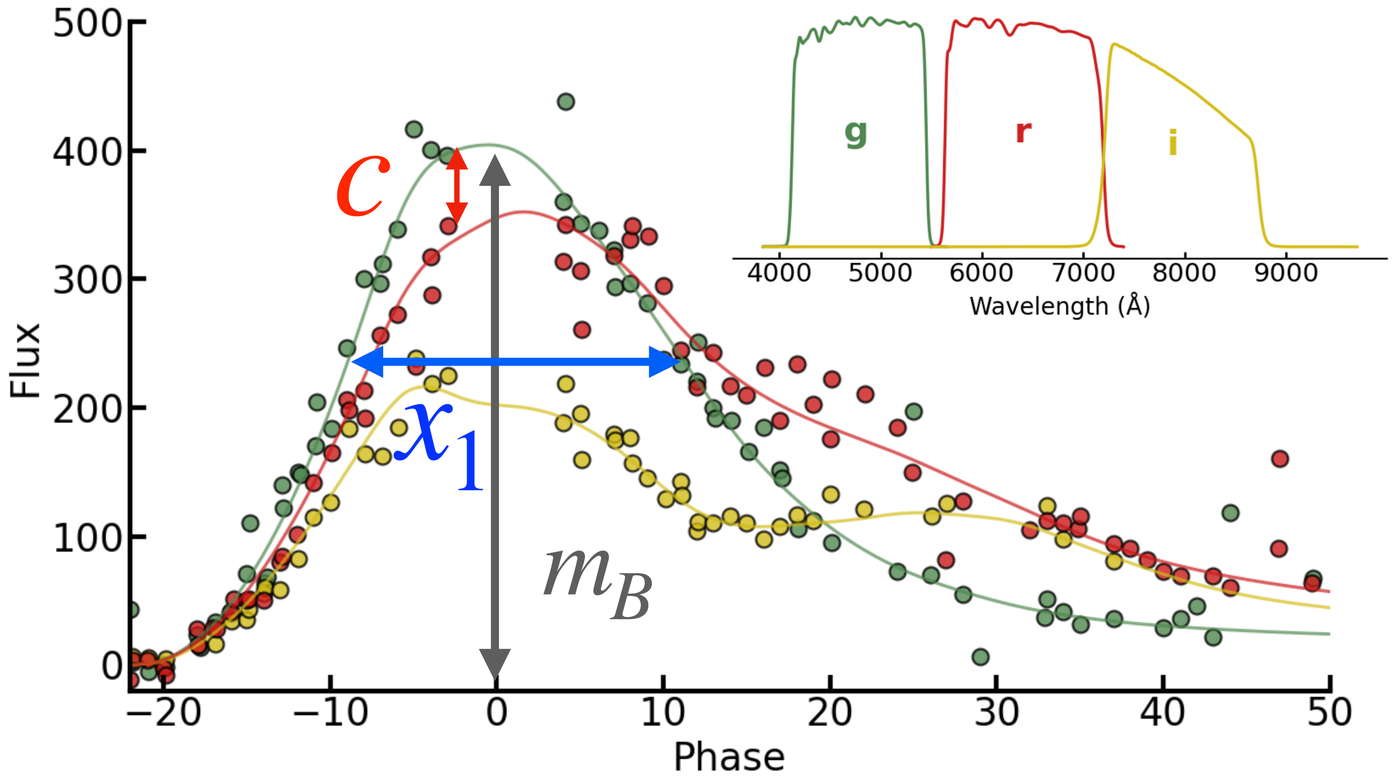
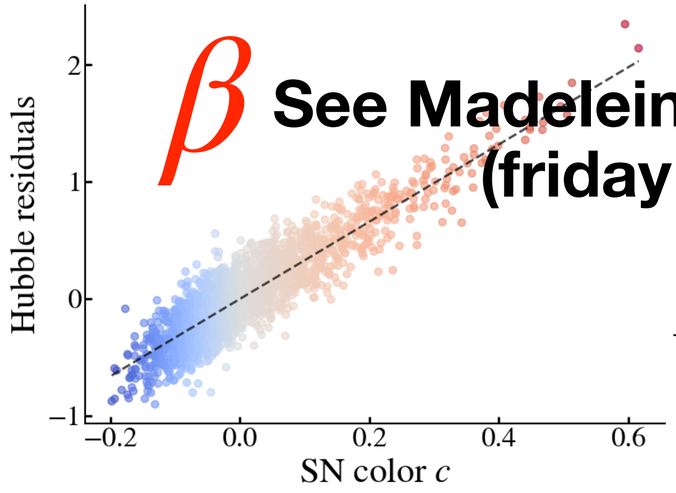
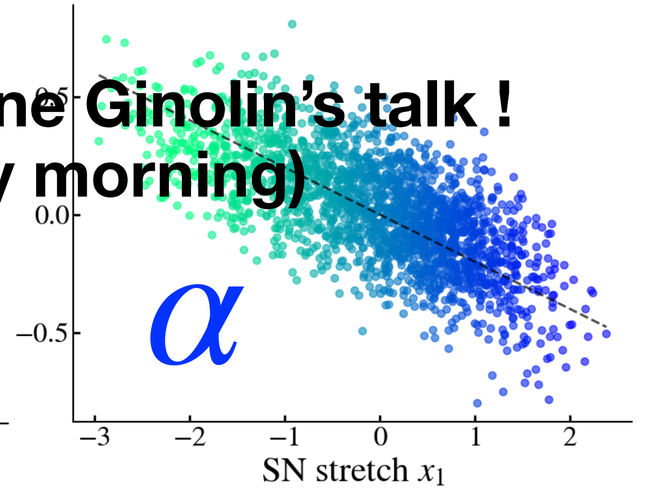






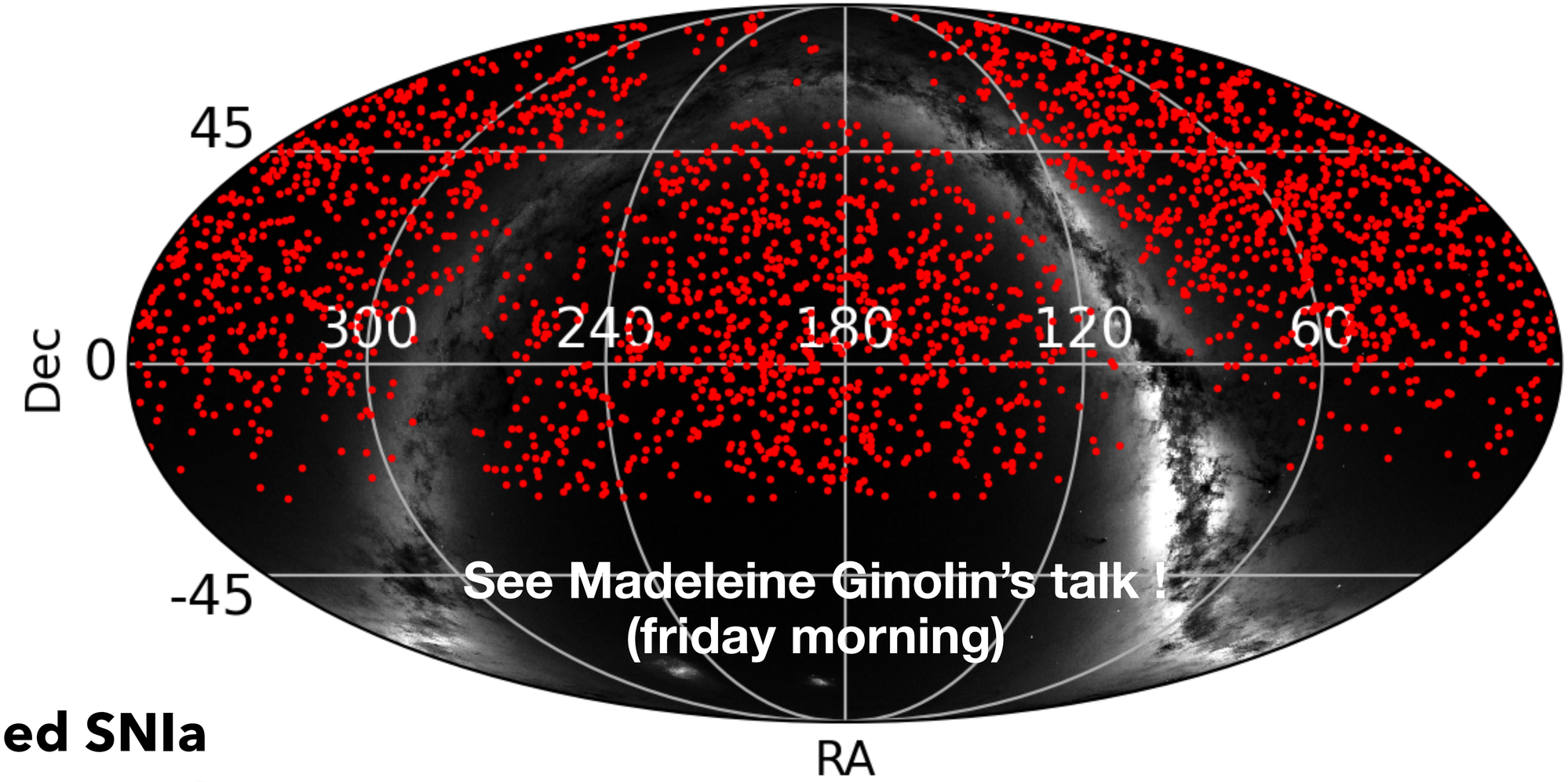
β **See Madeleine Ginolin's talk ! (friday morning)**



α

ZTF DR2

Presentation



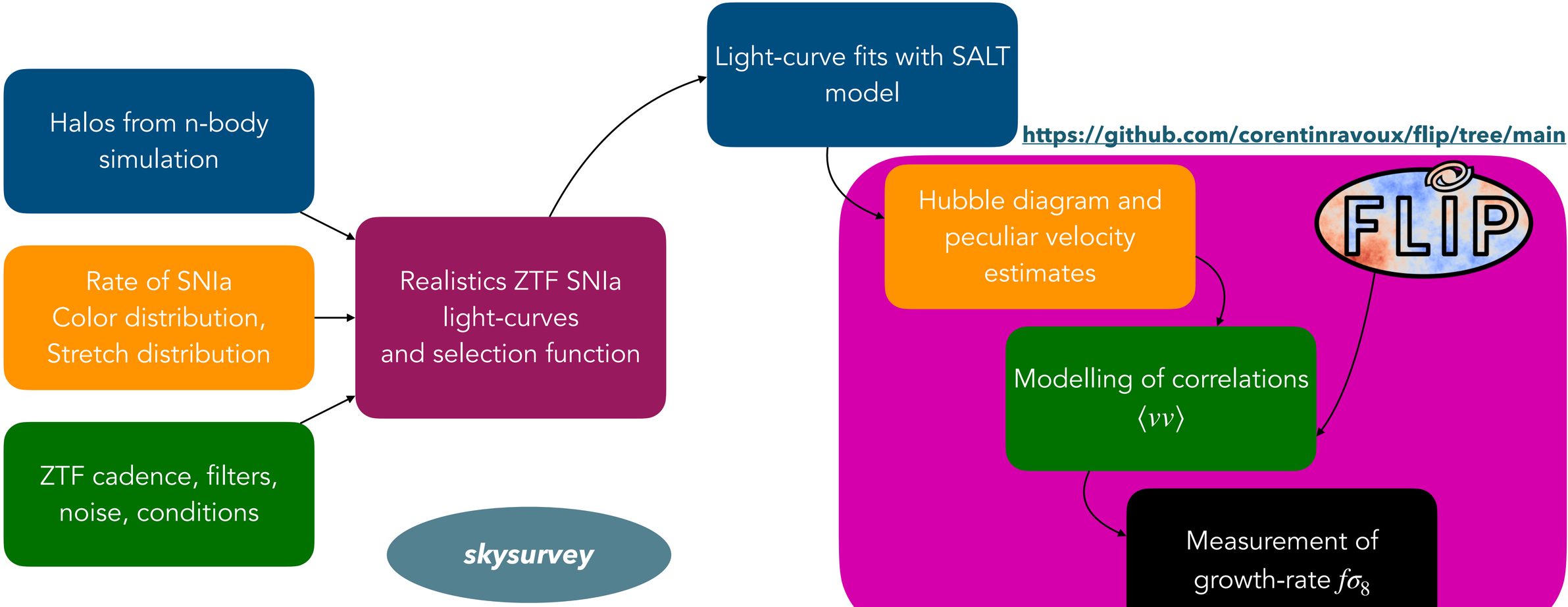
- **3628 Confirmed SNIa**
- **2629 pass the cosmology cuts**
- **994 in the complete sample**
- **Larger SNIa sample at low redshift**

DR2 Overview : Rigault et al 2025

Data available at : https://ztfcosmo.in2p3.fr/

$f\sigma_8$ pipeline

DAG



https://github.com/corentinravoux/flip/tree/main

https://github.com/MickaelRigault/skysurvey/tree/main

$f\sigma_8$ pipeline

Likelihood

$$\mathscr{L}(\mathbf{p}, \mathbf{p}_{\rm HD}) = (2\pi)^{-\frac{n}{2}} \, | \, C(\mathbf{p}, \mathbf{p}_{\rm HD}) \, |^{-\frac{1}{2}} \exp \left[-\frac{1}{2} \mathbf{v}^{\top}(\mathbf{p}_{\rm HD}) C(\mathbf{p}, \mathbf{p}_{\rm HD})^{-1} \mathbf{v}(\mathbf{p}_{\rm HD}) \right]$$

$$\mathbf{p} = f\sigma_8, \sigma_u, \sigma_v \qquad \mathbf{p}_{\rm HD} = \alpha, \beta, \sigma_{int}, M_0$$

Cosmological parameters **Hubble Diagram parameters**

$f\sigma_8$ pipeline

Likelihood

$$\mathscr{L}(\mathbf{p}, \mathbf{p}_{\rm HD}) = (2\pi)^{-\frac{n}{2}} |\, C(\mathbf{p}, \mathbf{p}_{\rm HD})\,|^{-\frac{1}{2}} \exp\left[-\frac{1}{2}\mathbf{v}^{\top}(\mathbf{p}_{\rm HD}) C(\mathbf{p}, \mathbf{p}_{\rm HD})^{-1}\mathbf{v}(\mathbf{p}_{\rm HD})\right]$$

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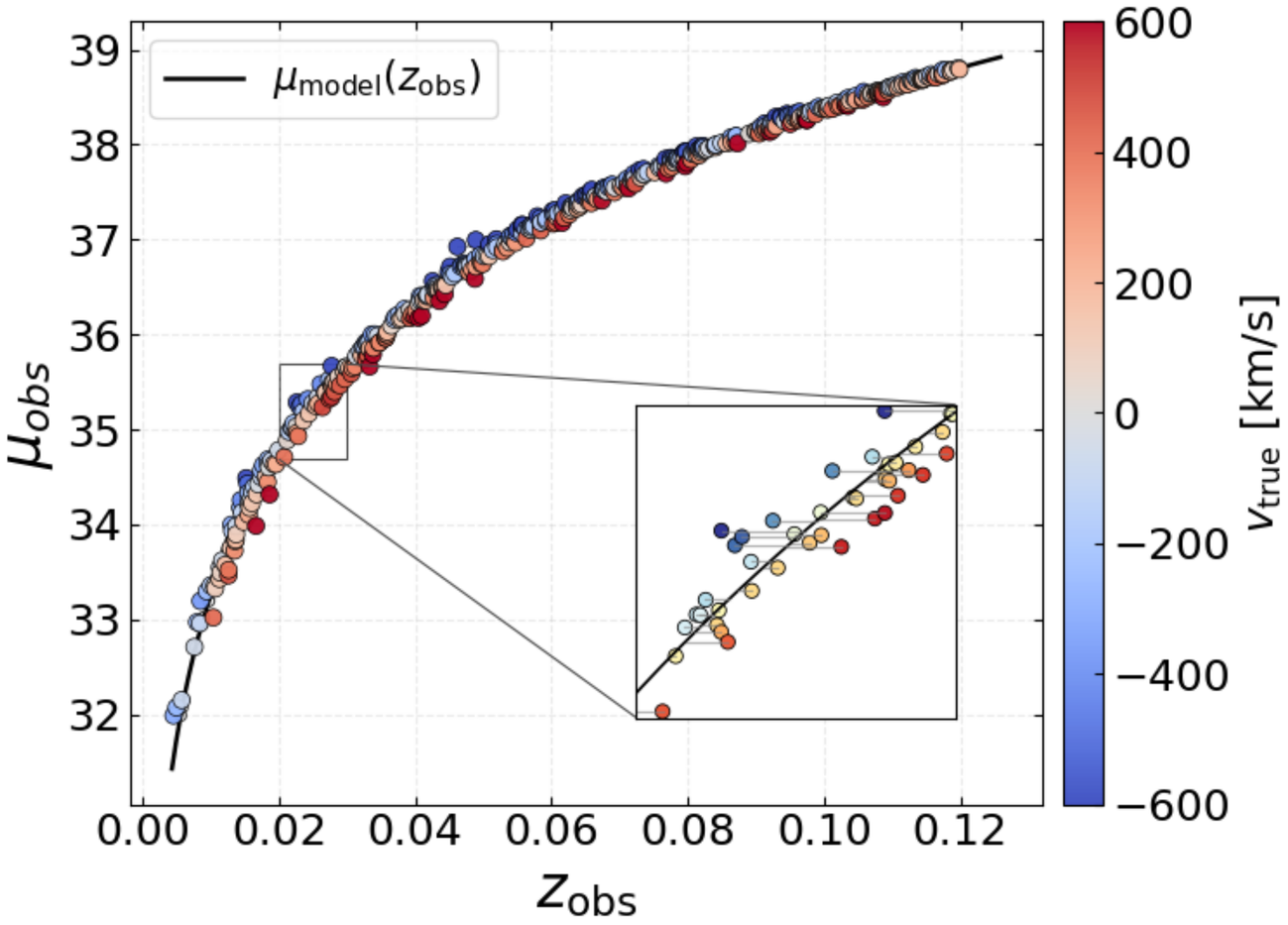
Hubble Diagram parameters



$$\mathbf{v}(\mathbf{p}_{\rm HD}) \propto \Delta\mu_i(\mathbf{p}_{\rm HD})$$

$$(1 + z_{obs}) = (1 + z_{cos})(1 + \frac{v_p}{c})$$

$f\sigma_8$ pipeline

Likelihood

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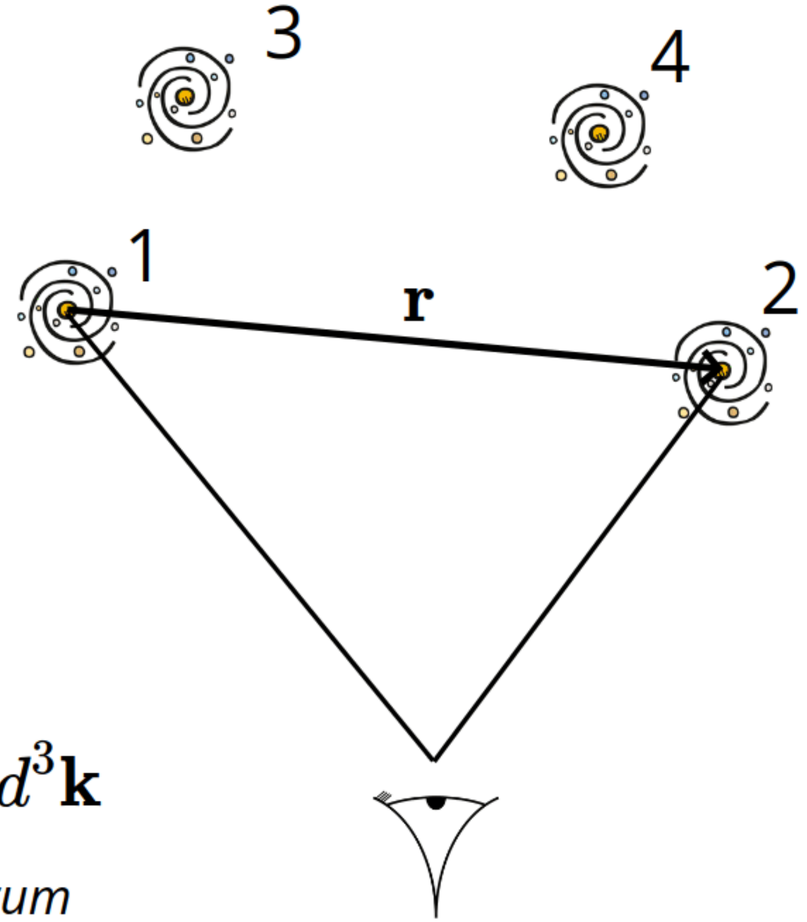
$$\mathcal{L}(p) \propto \exp\left[-\frac{1}{2}\begin{bmatrix}1\\2\\3\\4\end{bmatrix}^{T} \begin{vmatrix} & C_{12} \\ C_{21} & \end{vmatrix}^{-1} \begin{bmatrix}1\\2\\3\\4\end{bmatrix}\right]$$



Field covariance

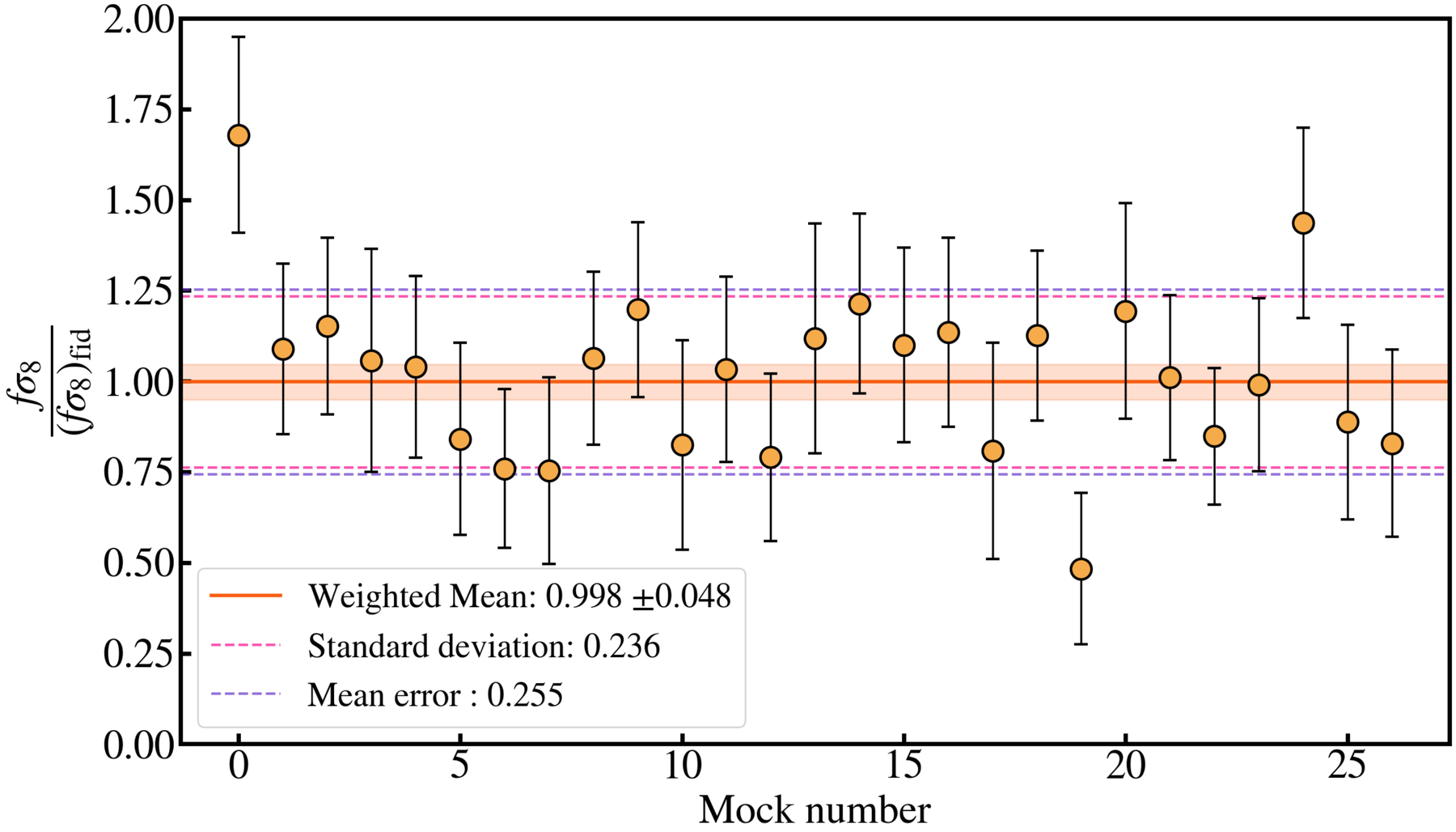
$$C_{\rm nm}(\mathbf{r_n}, \mathbf{r_m}) = \frac{1}{(2\pi)^3} \int_{\mathbf{k}} P_{\rm nm}(k, \mu_n, \mu_m)\, e^{i\mathbf{k}.\mathbf{r}}\, d^3\mathbf{k}$$

Theoretical power spectrum

Credit: Corentin Ravoux

$f\sigma_8$ pipeline

Results



Method works on realistic simulations !

In agreement with Carreres et al 2023

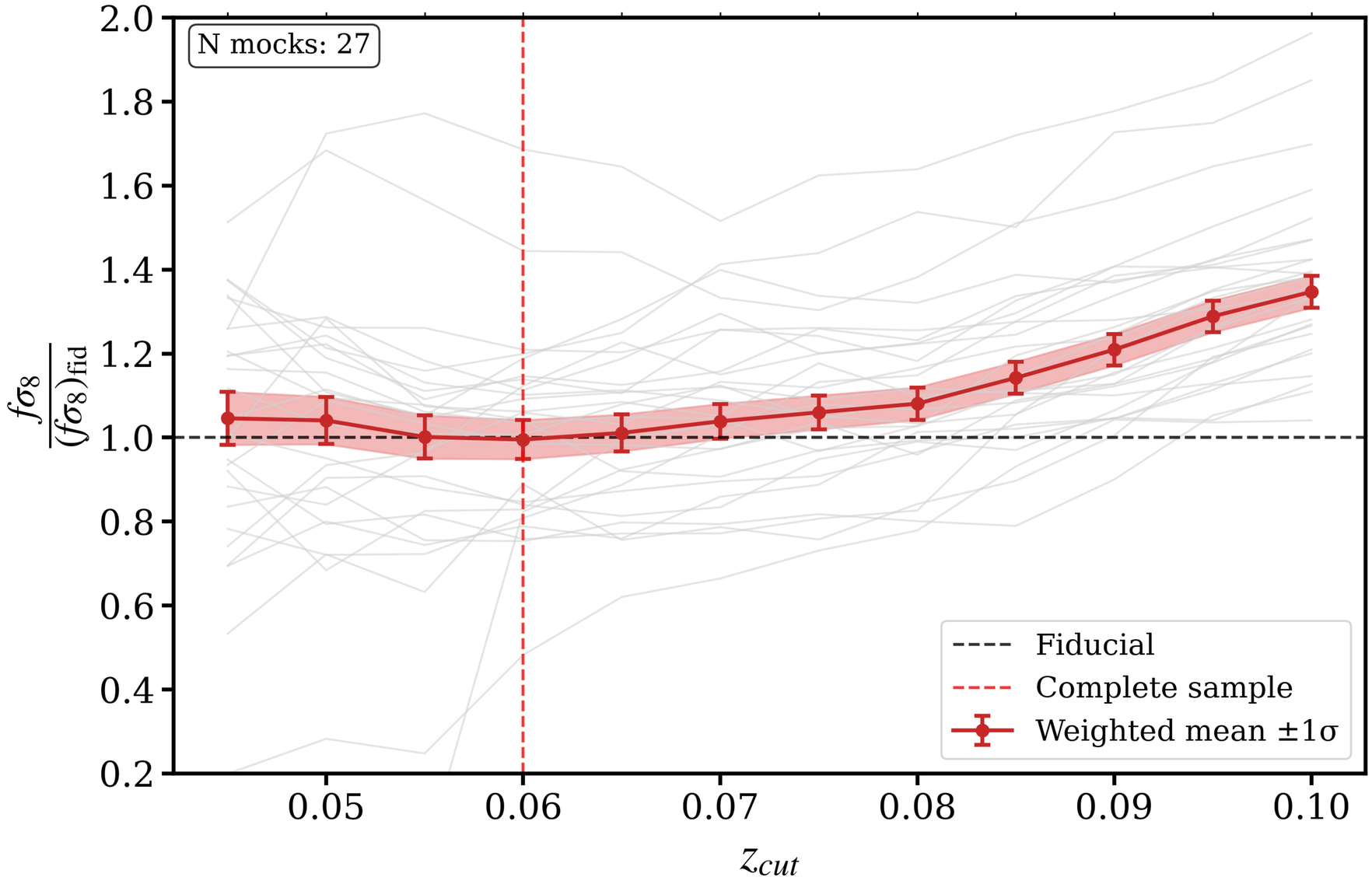
$f\sigma_8$ pipeline

Results

$f\sigma_8$ biaised for

$z_{cut} > 0.06$

In agreement with Carreres et al 2023



Systematics

Anisotropies

Angular correlation in the sky can biais $f\sigma_8$

Mis-calibration effects

Observation strategy

(in progress)

Effect of the Milky way dust

(to do)

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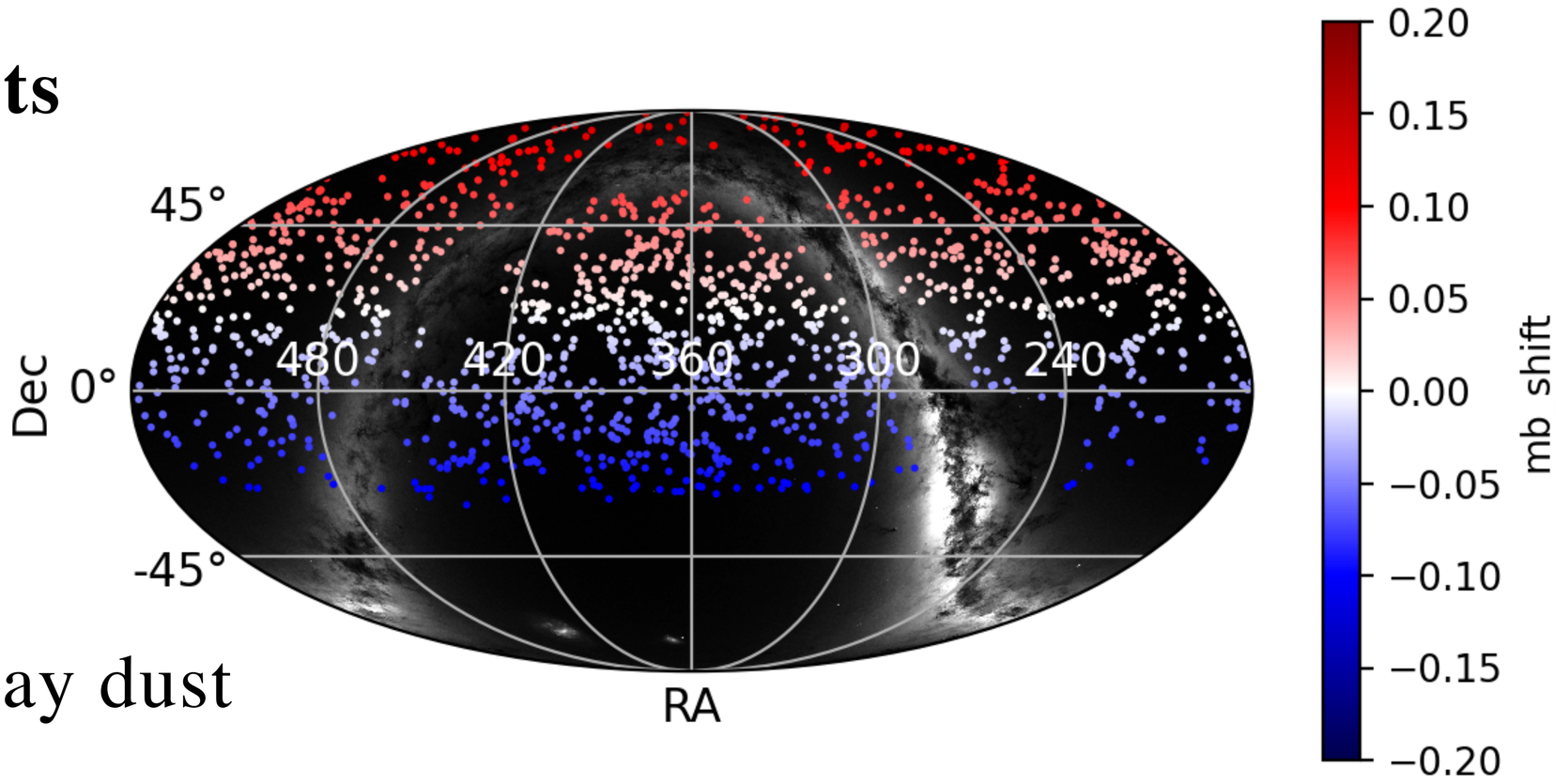

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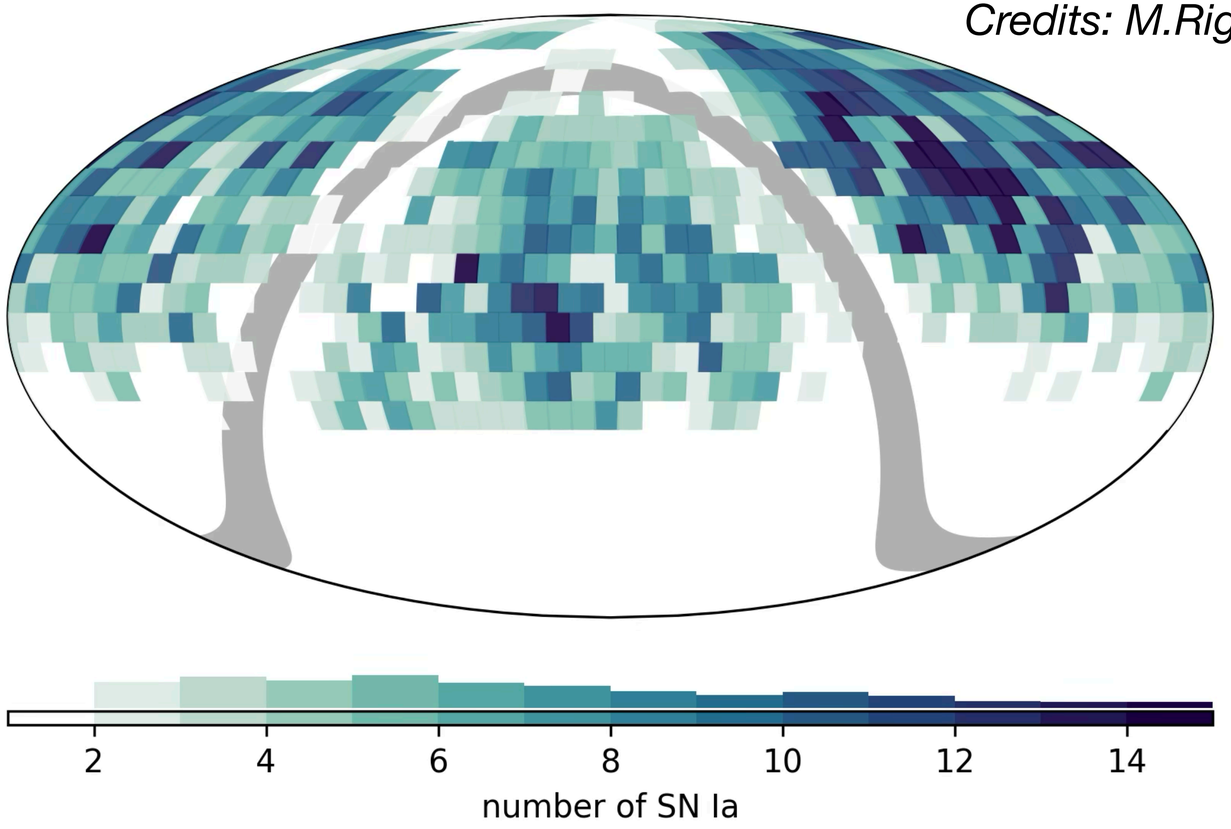
Credits: M.Rigault



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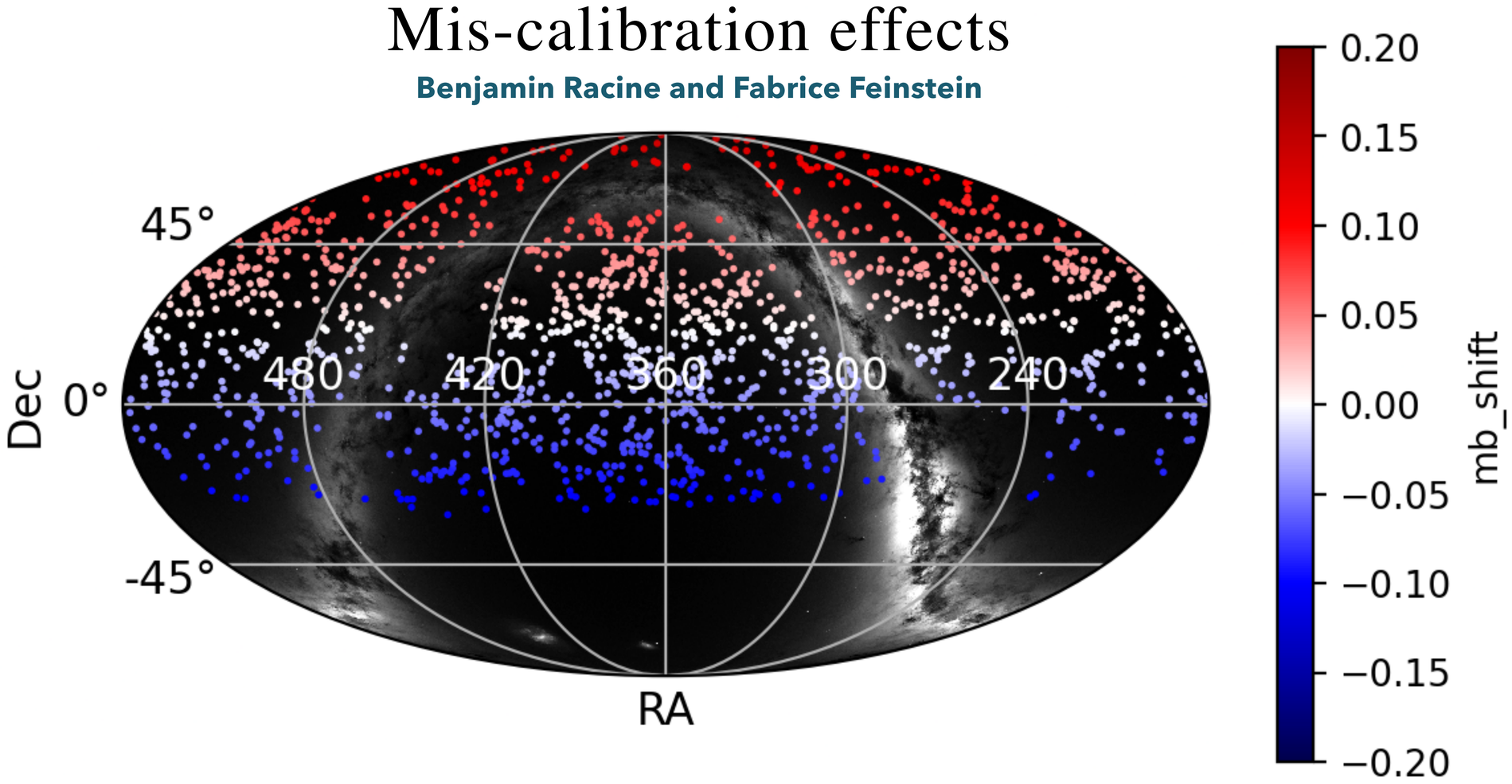
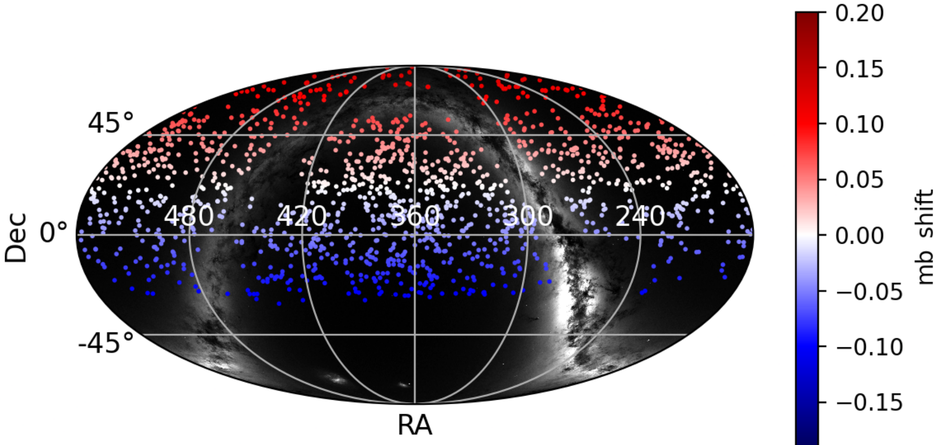
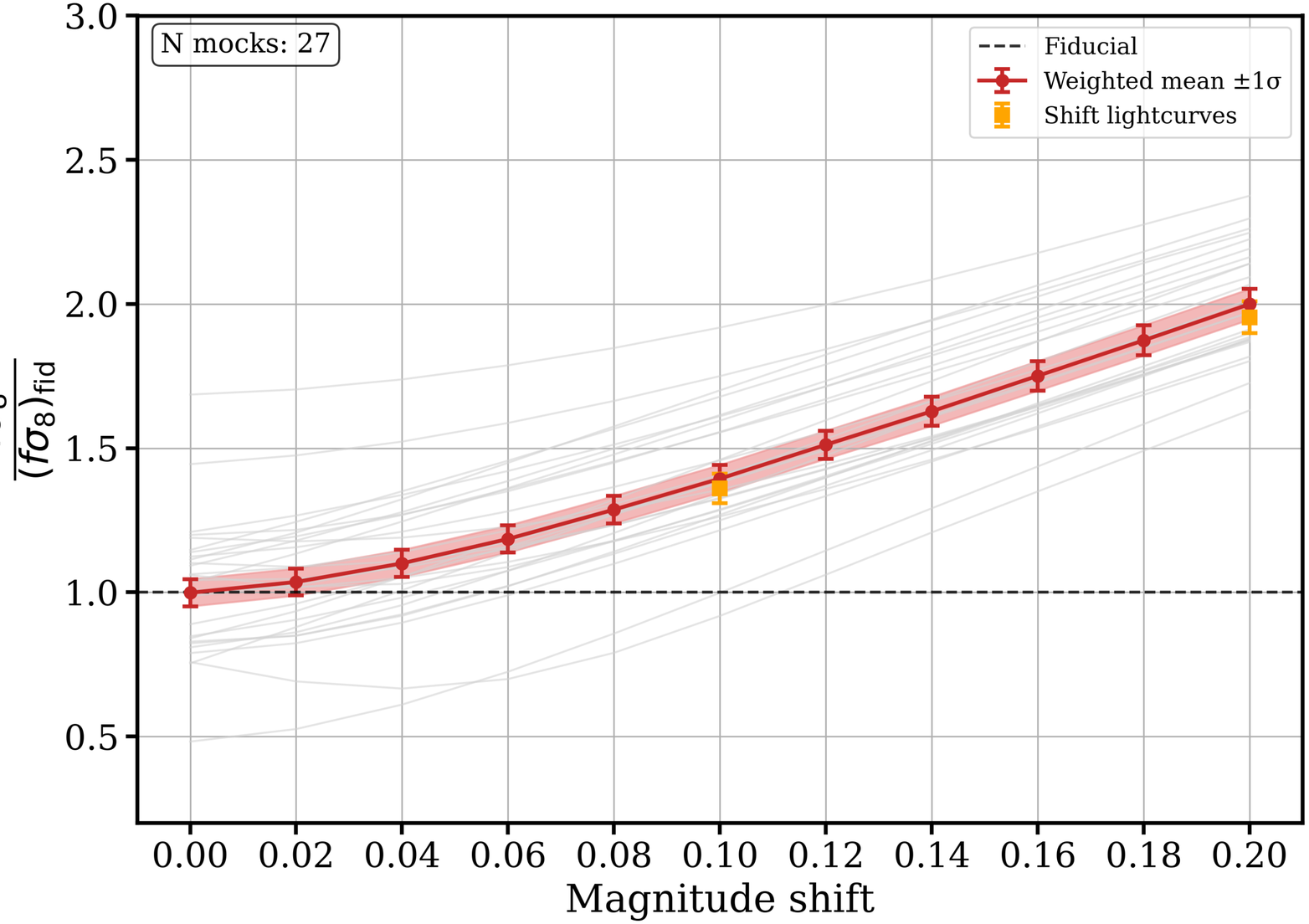


$f\sigma_8$ pipeline

Systematics





Conclusion

- Method works on realistic simulations
- Pipeline from simulations to $f\sigma_8$ is ready
- We start to look at the systematics

Thanks for your attention !