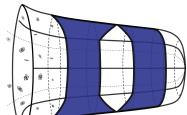DESC Project announcement:

Measurement of the growth-rate of structures using SN Ia PVs in the BBC framework
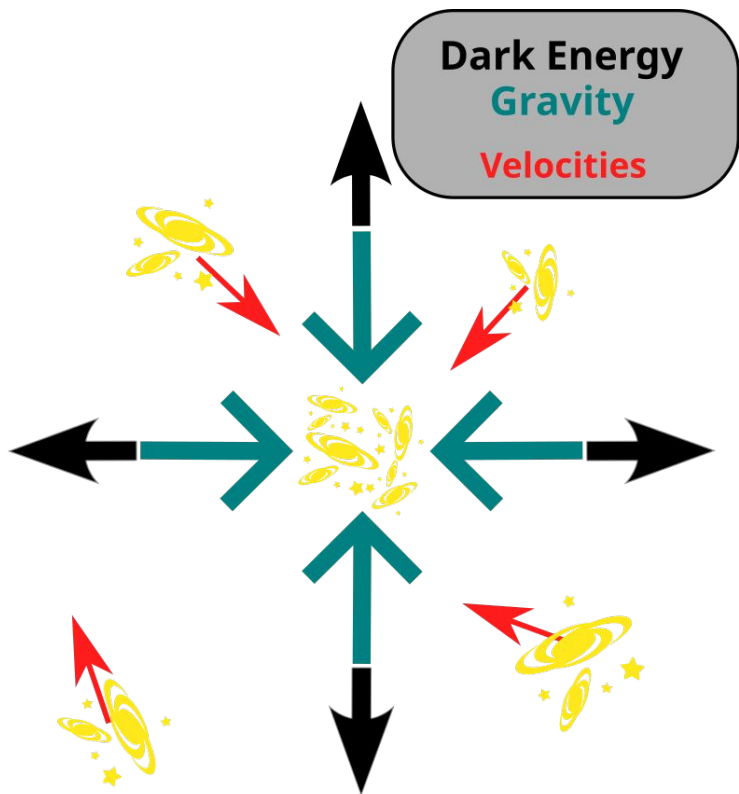
Bastien Carreres, Rebecca Chen, Erik Peterson, Daniel Scolnic, Damiano Rosselli, Corentin Ravoux
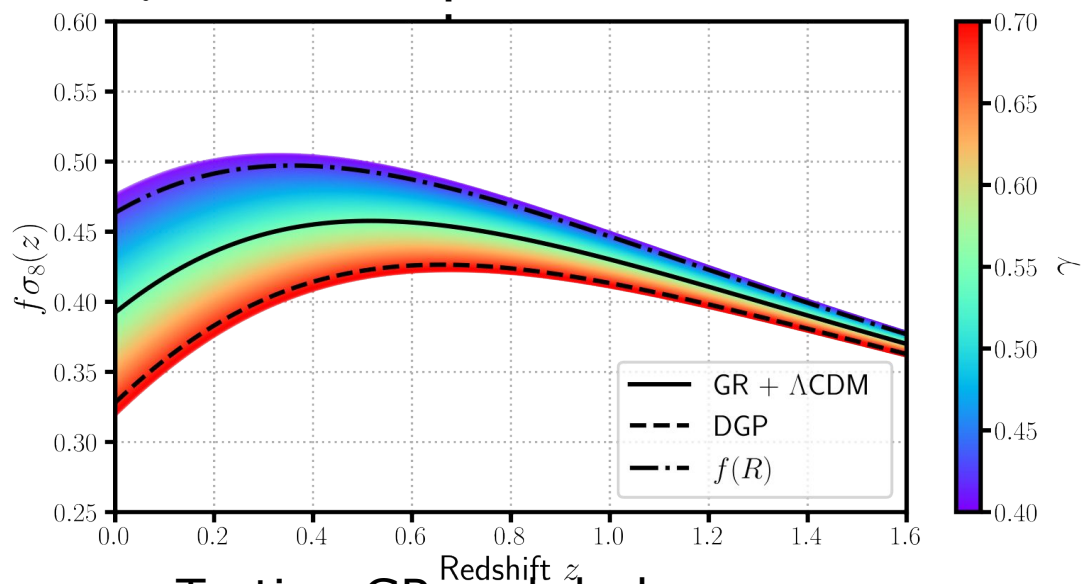
Duke Cosmology

Context: the Growth-Rate of structures

Dark Energy
Gravity
Velocities

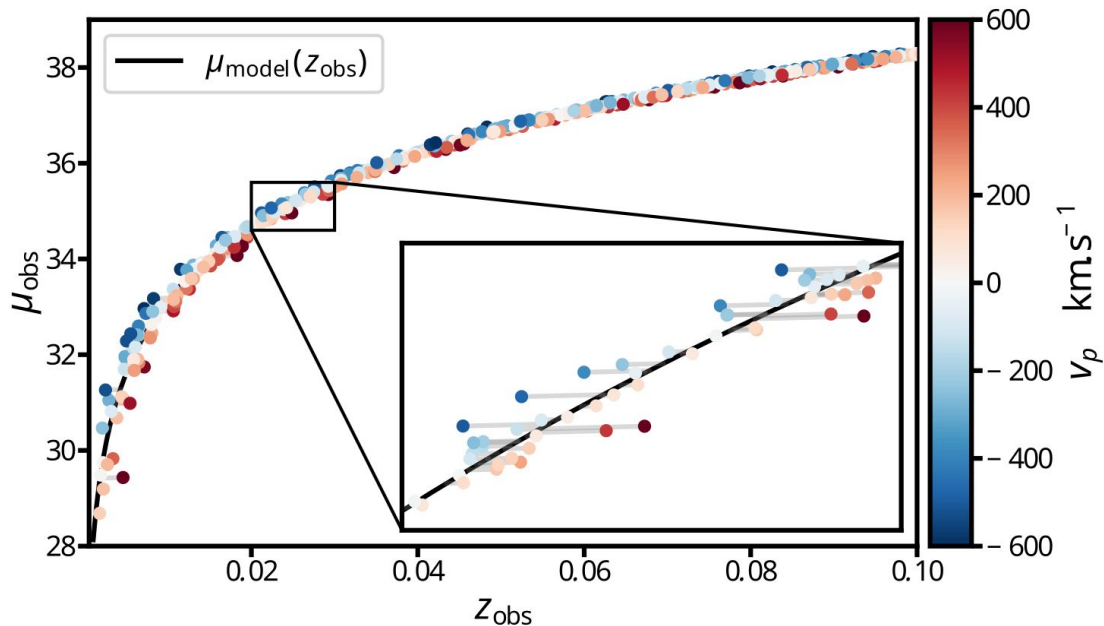$f\sigma_8$: rate of evolution of structure clustering, amplitude of the velocity field variance

$$f\sigma_8 \simeq \Omega_m^\gamma \sigma_8 \quad \text{GR} \quad \gamma \simeq 0.55$$
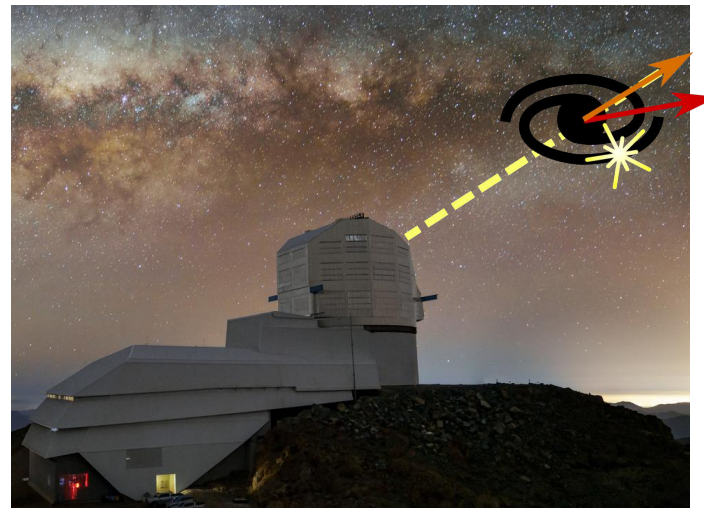

$f\sigma_8$ => Testing GR and dark energy models

Context: Measuring peculiar velocities with SNe Ia
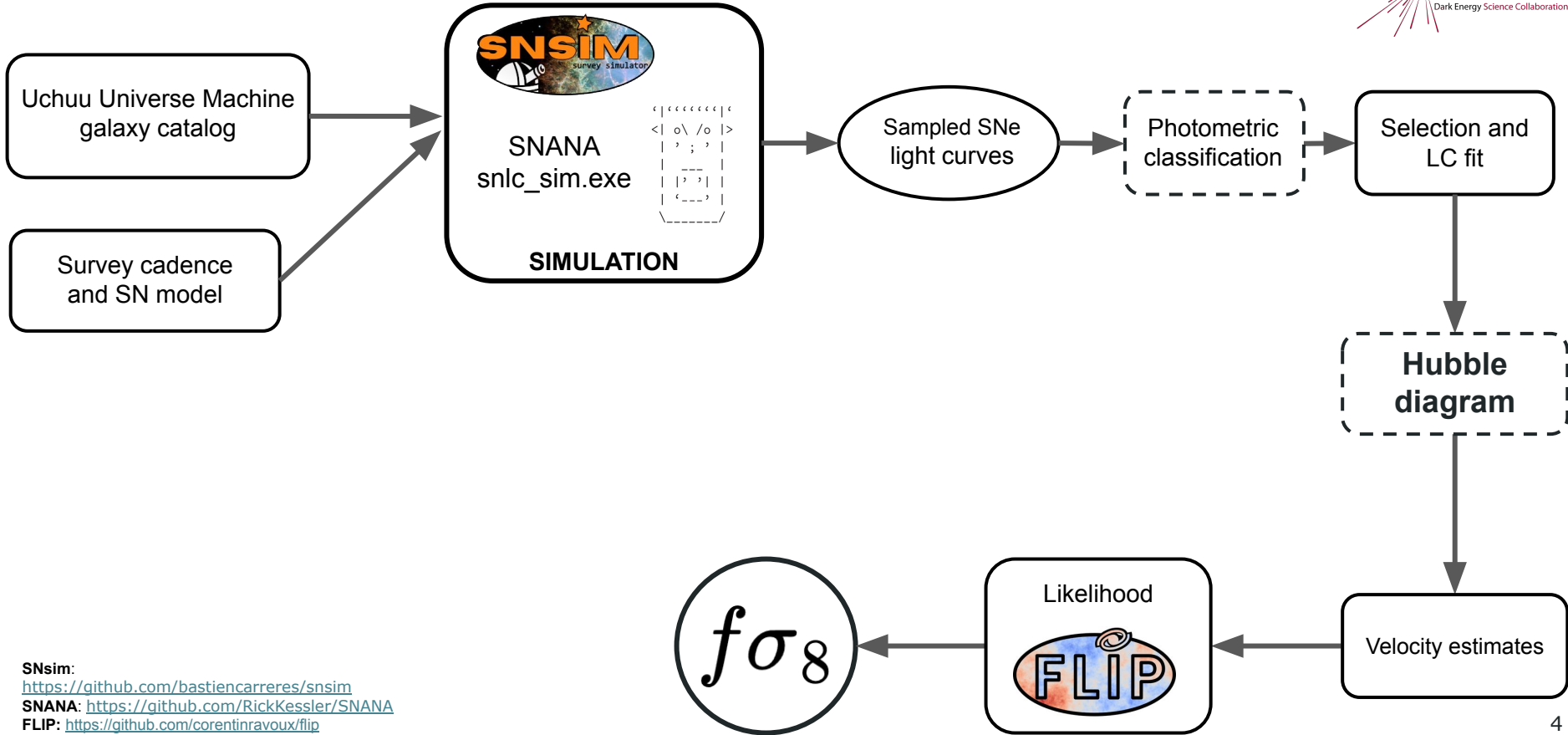
Peculiar velocities are estimated from SNe Ia HD residuals

$$1 + z_{\mathrm{obs}} = (1 + z_{\mathrm{cos}})(1 + v/c)$$

We only access the SNe Ia host' PV on the line-of-sight !

What does the current growth-rate pipeline look like?

What does this project focus on?

Uchuu Universe Machine galaxy catalog

Survey cadence and SN model

SNANA snlc_sim.exe

SIMULATION

Sampled SNe light curves

Effect of Photometric classification on fs8: DESC PROJECT 311

Selection and LC fit

Project goals:

Using SNANA and the BBC framework to investigate fs8 measurement systematics:

- Effect of intrinsic scatter models

Sample selection bias correction

BBC

$f\sigma_8$

Likelihood

FLIP

Velocity estimates

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=> Main source of systematics on w in DES-5YR sample… What about fs8?

BBC

$f\sigma_8$

Likelihood

FLIP

Velocity estimates

SNsim:
https://github.com/bastiencarreres/snsim
SNANA: https://github.com/RickKessler/SNANA
FLIP: https://github.com/corentinravoux/flip

Details on simulations

PV field

Uchuu Universe Machine galaxy catalog
- Use Planck15 cosmology
- 2 Gpc/h box with galaxies along with their mass and sfr
- Magnitudes / sersic profiles of gals in LSST band are added using an interpolation on LSST+Roman Diffsky sims

8 Uchuu mocks for LSST "data" simulations	+	1 Uchuu mock for BBC sample simulation

LSST observations

Opsim output : baseline_v3.3_10yrs

Use OpSimSummaryV2 library to obtain SNANA inputs: SNANA SIMLIB + SNANA HOSTLIB

SN Ia are simulated using the SALT3 model

Stretch X1 and color C distributions depends on host mass and are the same as the one used for DES-5 year low-z simulations.

To address the **chromatic scattering systematic**, simulations are run for 4 differents scatter model:

- Achromatic intrinsic scattering with σ=0.12
- G10 model: ~70% achromatic ~30% chromatic
- C11 model: ~25% achromatic ~75% chromatic
- BS20 + P21 model: Dust based model

Bias correction simulations are run with the same 4 models + P21 variation used in *Vincenzi et al. 2024*
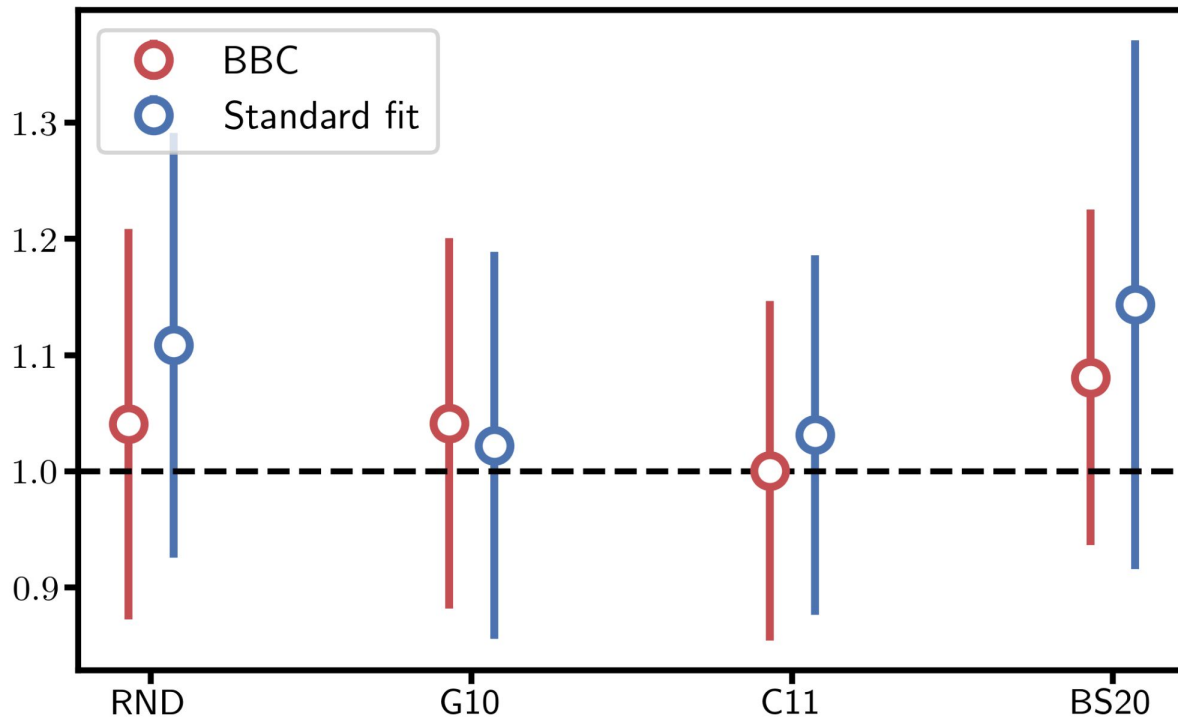
Preliminary results: color systematic

Standard fit: fitting standardisation parameters (α, β, M0) along with fs8 using likelihood maximisation.

BBC: applying bias correction + fit for α, β and M0, then fit for fσ8.
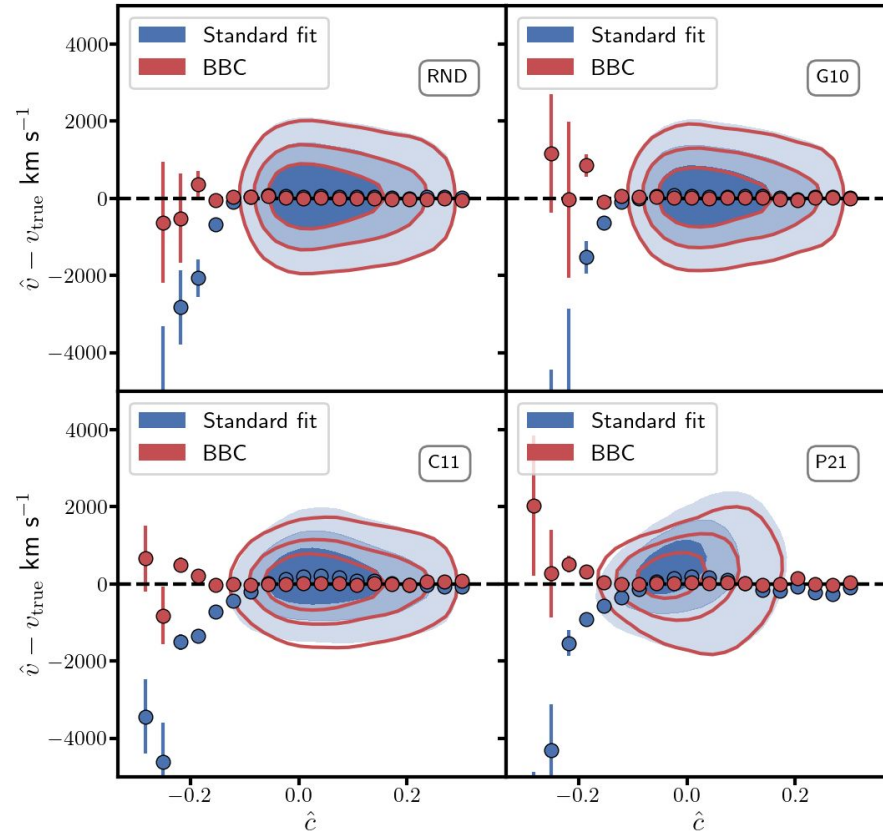
Preliminary results: color systematic

Fit in the [0.02, 0.1] redshift range

Similar results but for P21 the error from standard fit is 1.6 times bigger than the one from BBC fit !

Next main steps

- Run the simulation + apply bias correction (tweaking BBC parameters) for all the mocks

- Compute covariance matrix from intrinsic scatter models

- Quantify the intrinsic scattering systematic on $f\sigma 8$ measurements

Thanks for your attention

If your interested don't hesitate to sign on the project' confluence page and to follow the #peculiar-velocities slack channel ! (We do bi-weekly meeting on friday)