Affine Inflation

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Conference on Inflation and CMB,
17-21 July, 2017
NORDITA, Stockholm.

The talk is based on:
H. Azri, D. Demir, Phys. Rev. D 95, 124007 (2017) [arXiv:1705.05822 [gr-qc]]

Nonminimal to Minimal Coupling in Affine Gravity

Nonminimal Coupling

H. Azri, D. Demir (2017)

$$\int d^4x \frac{\sqrt{\mathrm{Det}\left[\left(M_{Pl}^2+\xi\phi^2\right)\mathcal{R}_{\mu\nu}\left(\Gamma\right)-\partial_\mu\phi\partial_\nu\phi\right]}}{V(\phi)}.$$

- Kinetric term enters the volume element
- Potential is not added to it but enters in division
- Potential must never vanish.
- Nonzero vacuum energy defines a tensor

$$T^\mu_\nu = V(\phi_{min})\delta^\mu_\nu.$$

$$\longrightarrow \quad {}^T\Gamma^\lambda{}_{\mu\nu} = \frac{1}{2}(T^{-1})^{\lambda\rho}\left(\partial_\mu T_{\nu\rho}+\partial_\nu T_{\rho\mu}-\partial_\rho T_{\mu\nu}\right)$$

Mapping to Minimal Coupling

$$\int d^4x \frac{\sqrt{\mathrm{Det}\left[M_{Pl}^2\mathcal{R}_{\mu\nu}\left(\Gamma\right)-\partial_\mu\varphi\partial_\nu\varphi\right]}}{U\left(\varphi\right)},$$

- Not conformal transformation, but only field redefinition is required:

$$d\varphi = \frac{d\phi}{\sqrt{1+\frac{\xi\phi^2}{M_{Pl}^2}}}, \qquad U[\varphi(\phi)] = \frac{V(\phi)}{(1+\frac{\xi\phi^2}{M_{Pl}^2})^2}$$

- Example of a nonzero potential:

$$V(\phi) = V_0 + \frac{\lambda}{4}(\phi^2-v^2)^2 \longrightarrow V\left(\phi_{min}\right) \neq 0.$$

with nonzero cosmological constant

$\Lambda = V_0/M_{Pl}^2$ where $V_0 \sim m_\nu^4,$

Affine Gravity to Metric Gravity

Affine variational principle

$$\delta S = 0 \longrightarrow (M_{Pl}^2 + \xi\phi^2)\mathcal{R}_{\mu\nu} - \partial_\mu\phi\partial_\nu\phi = \left(\frac{V(\phi)}{V(\phi_{min})}\right)\left(\frac{M_{Pl}^2}{M_{Pl}^2 + \xi\phi^2}\right)T_{\mu\nu}.$$

- Vacuum energy sets metrical geometry:

$$T_{\mu\nu} = V(\phi_{min})g_{\mu\nu}$$

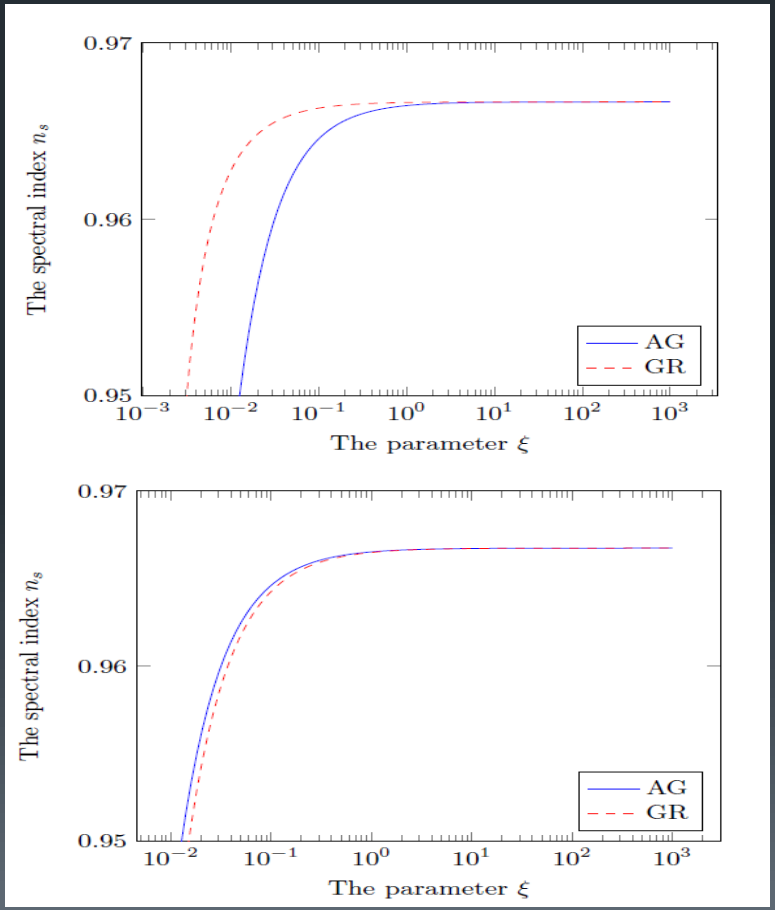
- Spectral index and tensor to scalar ratio
  H. Azri, D. Demir (2017)

$$n_s \simeq 1 - \frac{3}{4\xi N^2} - \frac{2}{N}. \qquad r \simeq \frac{2}{\xi N^2}.$$

- Planck data implies

$$\xi \gtrsim 3.12 \times 10^{-2} \;\&\; \lambda/\xi \sim 7.8 \times 10^{-11}$$

AG vs GR



Thank you for your attention

For more details, check:

H. Azri, D. Demir, Phys. Rev. D 95, 124007 (2017)
[arXiv:1705.05822 [gr-qc]].

Dissipation of acoustic waves $\mu \sim \int \mathrm{d}^3 k\, P_\zeta$, $P_\zeta = P_1 + P_2 \rightarrow$ scan over $(n_i, \alpha_i, \beta_i, R)$, $i = 1, 2$.

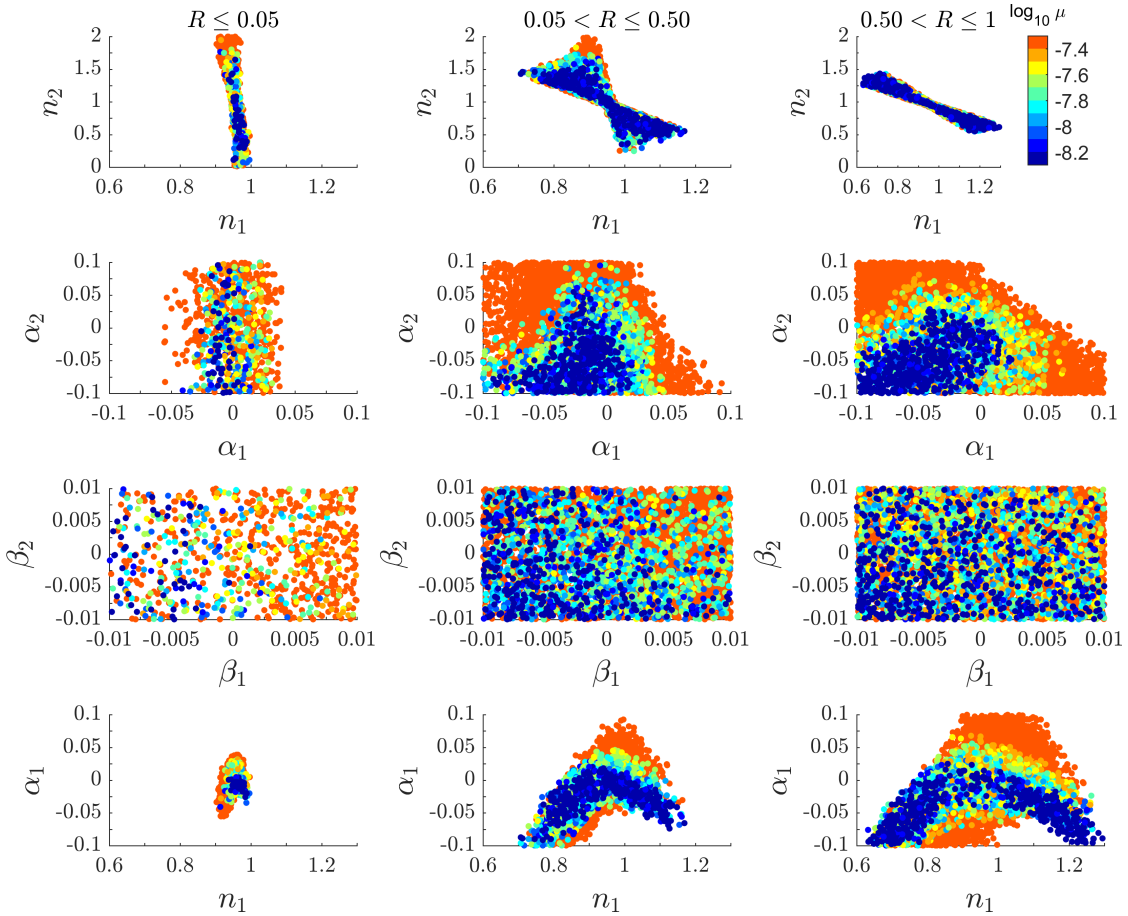


Figure: Scatter plots showing the μ distortion as function of the two-field model parameters compatible with the Planck bounds $n_s = 0.9586 \pm 0.0056$, $\alpha_s = 0.009 \pm 0.010$ and $\beta_s = 0.025 \pm 0.013$ at 99 % C.L. The limit $R = 0$ corresponds to the single field case and for $R = 1$ both fields contribute equally to the curvature perturbation. From a scan of 5×10^6 sets $\sim 10^4$ fall within these constraints.

Scan over (slow roll) parameters $(\epsilon_\phi, \eta_\phi, \xi_\phi, \sigma_\phi, \eta_\chi, R) \rightarrow (n_i, \alpha_i, \beta_i, R)$, $i = \phi, \chi$.

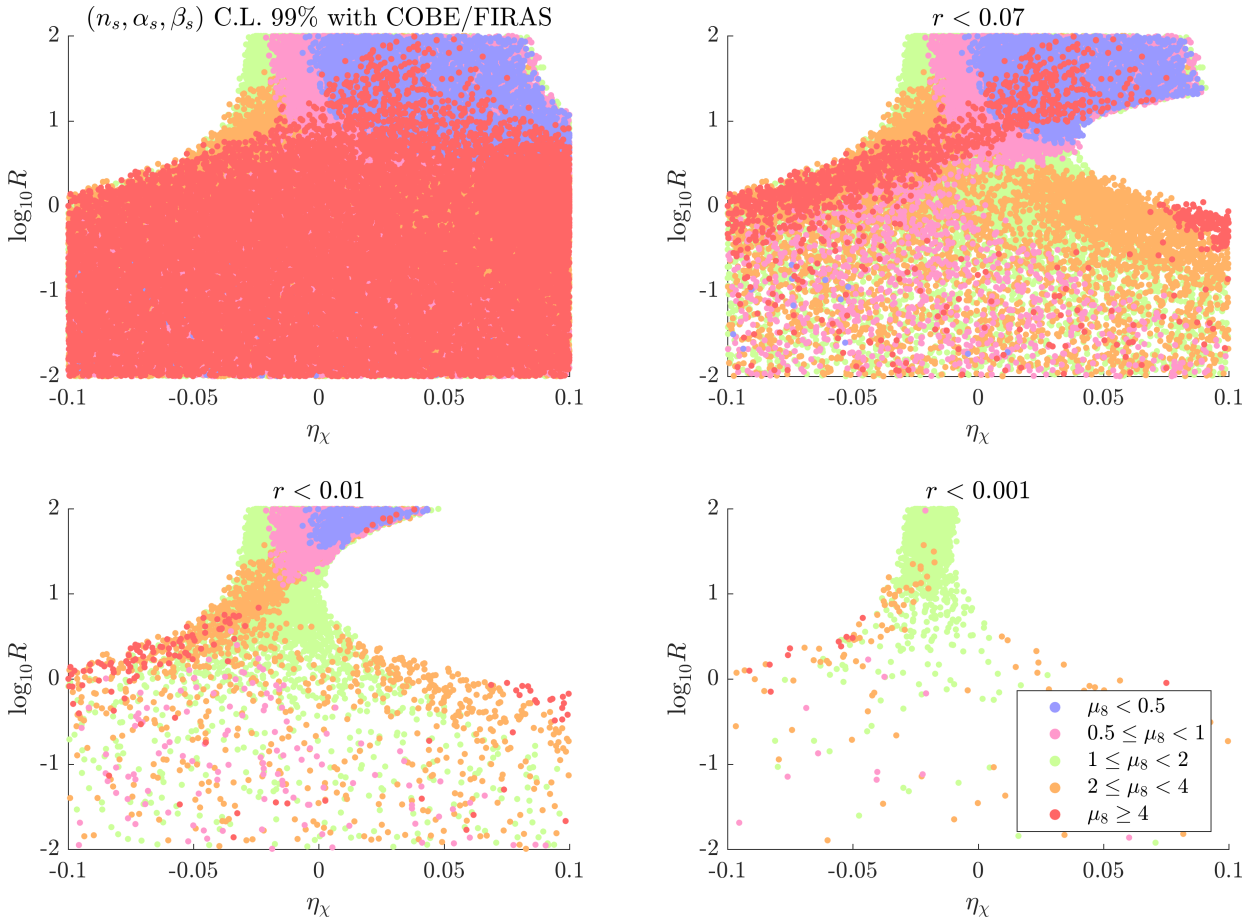


Figure: Scatter plots showing the μ distortion in the mixed inflaton-curvaton setup as function of the curvaton parameters η_χ and R. The depicted points are compatible with the Planck bounds at 99 % C.L. The limit $R = 0$ corresponds to inflaton domination and $R \gg 1$ curvaton domination.

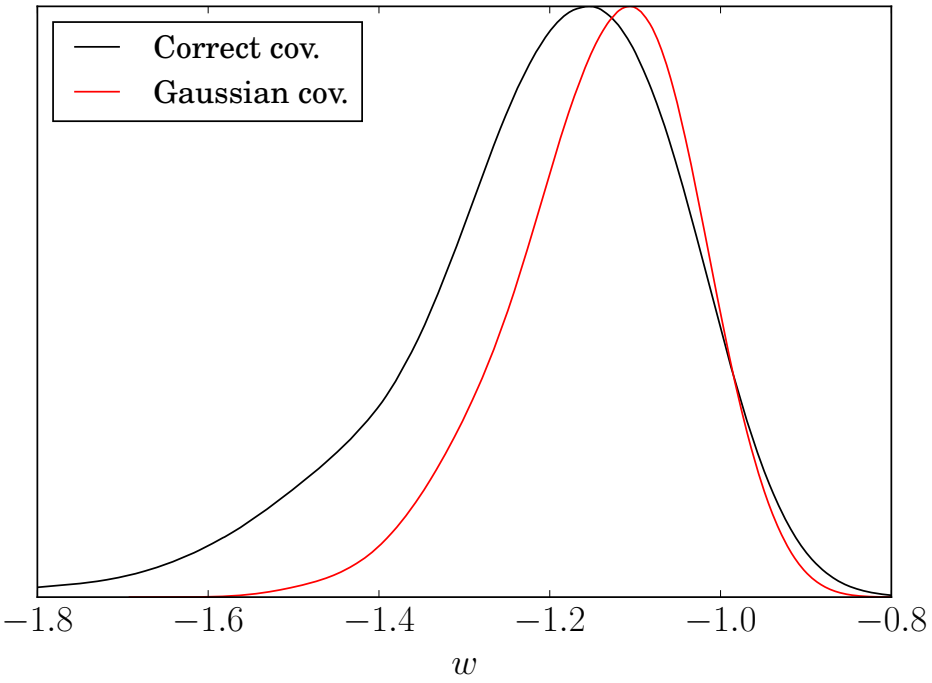
Pavel Motloch
U. Chicago

Consequences of lensing-induced covariance of CMB data

- CMB T, polarization gravitationally lensed by the same large scale structure
  ⟶ lensed power spectra correlated

- Has to be included into CMB-S4 likelihood

- For example − MCMC likelihood analysis of simulated T, pol. power spectra in ΛCDM + w



PM, W. Hu, in prep.

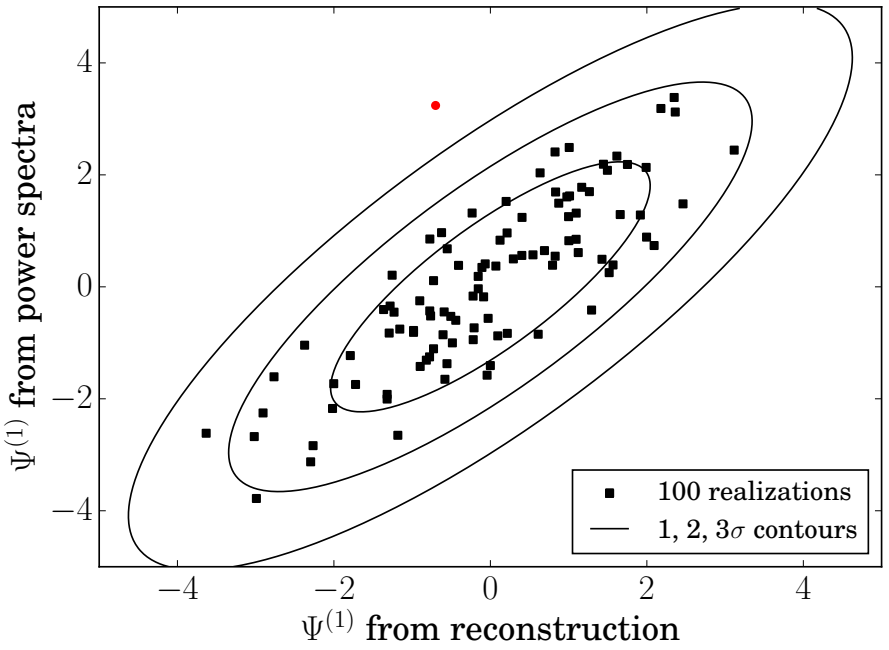
Pavel Motloch
U. Chicago

Consequences of lensing-induced covariance of CMB data

- Consistency check: Measure ``amount of lensing'' by quadratic reconstruction / from lensed C^{TT}, C^{EE}, … and compare

- Use $\Psi^{(1)}$, the most correlated combination of $C^{\phi\phi}$, instead of A_L

- Once check of lensed maps OK, start delensing



PM, W. Hu, A. Benoit-Levy, arXiv:1612.05637

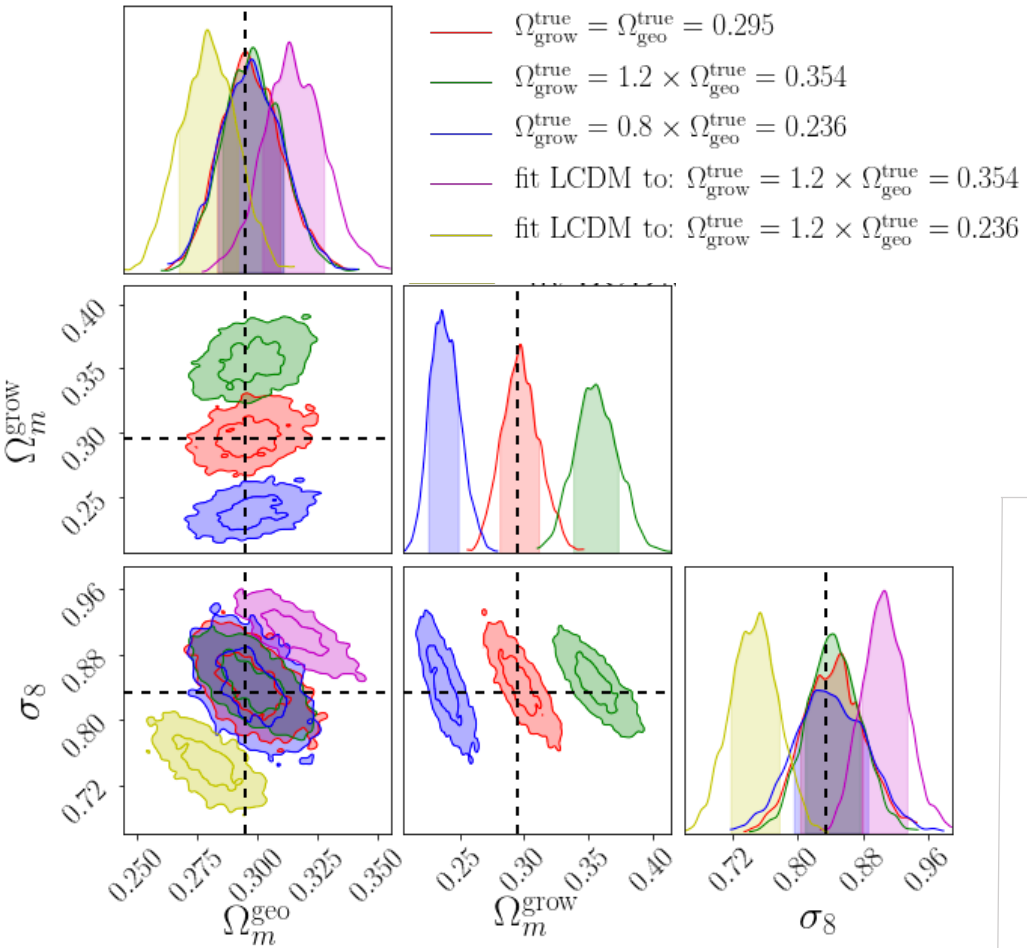
Testing ΛCDM with DES

Jessie Muir (advisor: Dragan Huterer)

DARK ENERGY SURVEY

UNIVERSITY OF MICHIGAN

Simulated DES-Y1-like clustering & lensing
+ Planck (geometry only) & JLA



Growth-geometry split

with Eric Baxter, Vinicius Miranda, DH, Bhuvnesh Jain

- Split DE-related parameters into versions constrained by growth and geometry (expansion) to test LCDM(+GR).
- Testing pipeline on simulated data, with plans to analyze DES Y1 data after the main cosmology papers are out.

Multi-probe blinding for Year-3

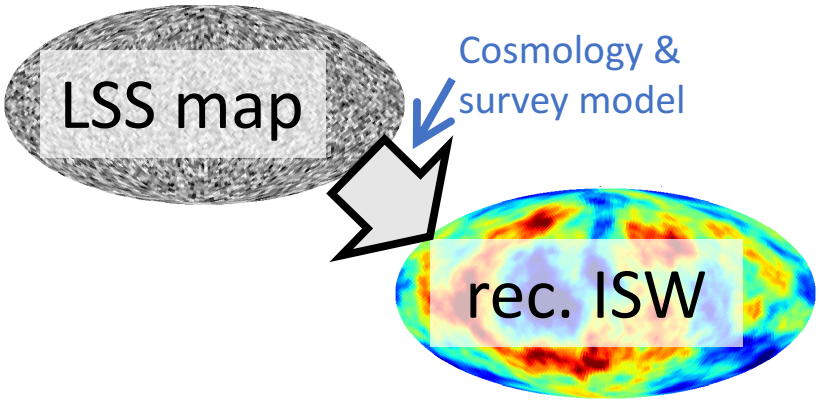
with Franz Elsner, Gary Bernstein, DH

- Multiply 2pt by particular linear scaling factor to shift output best-fit cosmology.
- Methods paper in prep.

Understanding large-angle CMB features

Jessie Muir (advisor: Dragan Huterer)

UNIVERSITY OF MICHIGAN



The impact of calibration errors on ISW reconstruction

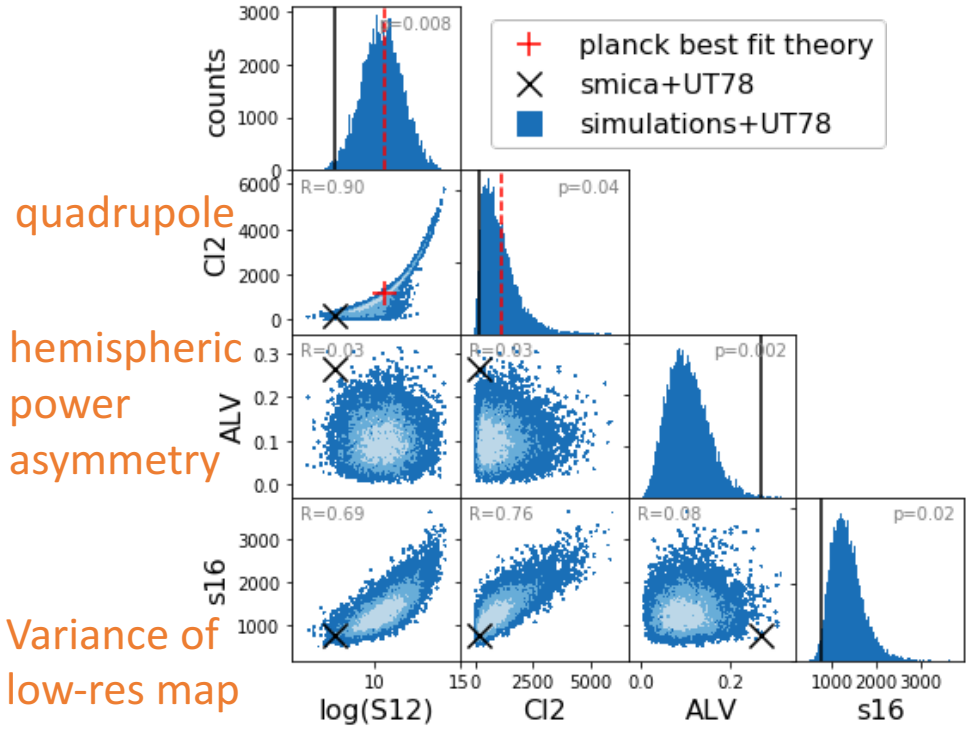
with Noah Weaverdyck & DH

- JM & DH, Phys. Rev. D **94**, 043503: Photometric calibration errors limit ISW signal reconstruction.
- Weaverdyck, JM, & DH, in prep: Can we mitigate this by combining multiple probes and/or modeling residual calibration errors?

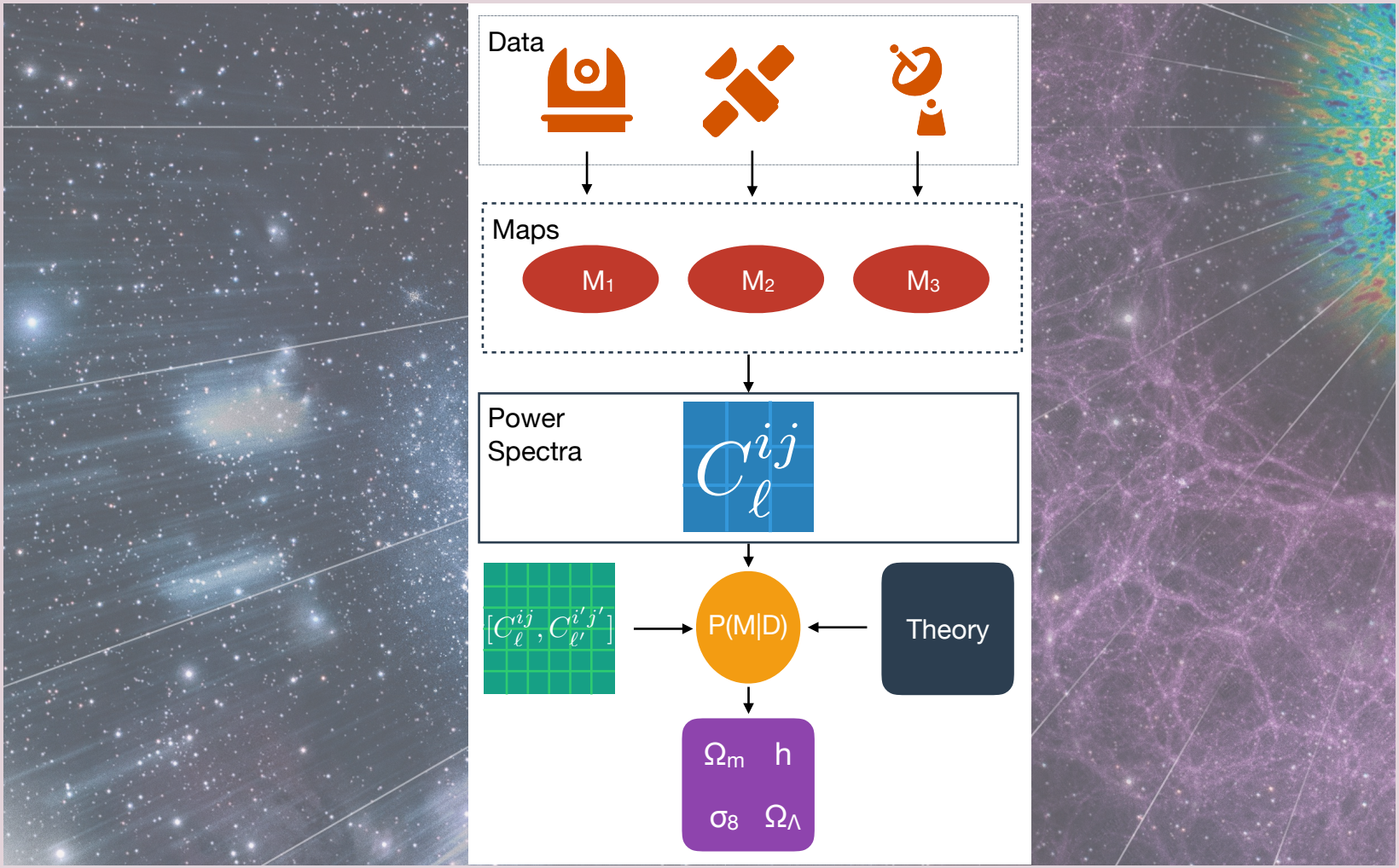
Covariance of large-angle anomalies

with Saroj Adhikari & DH

- Looking at 7+ features studied in literature
- Using 100k synfast simulations, 1k Planck FFP sims
- Studying impact of mask, foregrounds



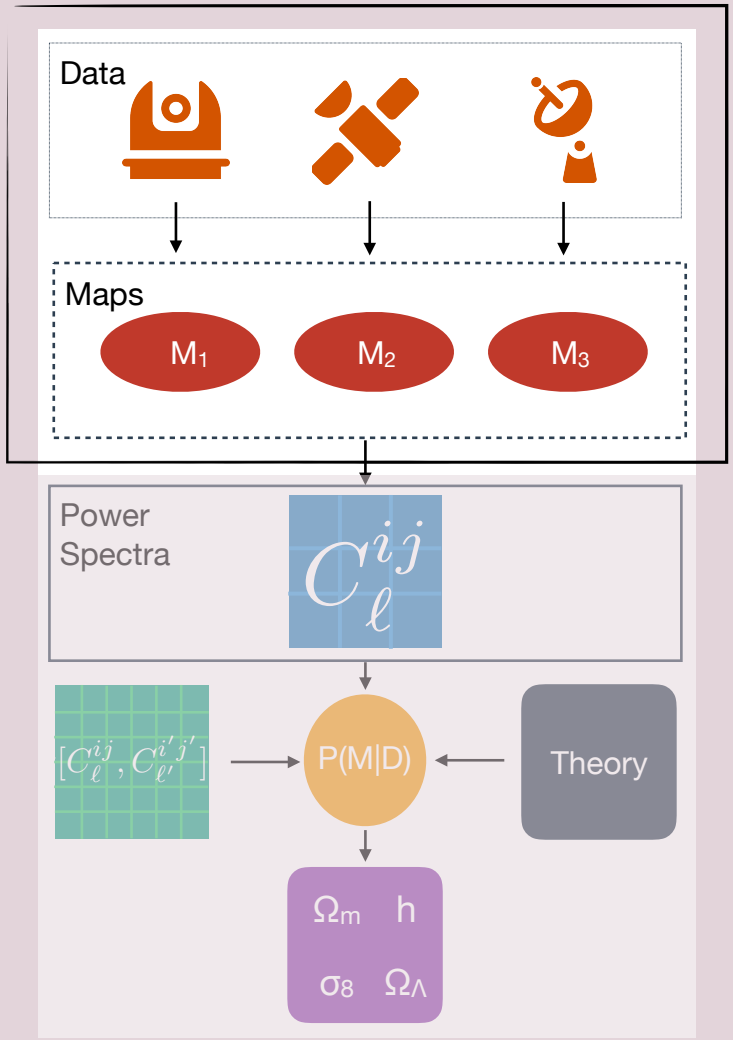
Integrated approach to cosmology



Andrina Nicola
with Alexandre Refregier and Adam Amara

Stockholm
18th July 2017

Maps, power spectra & constraints



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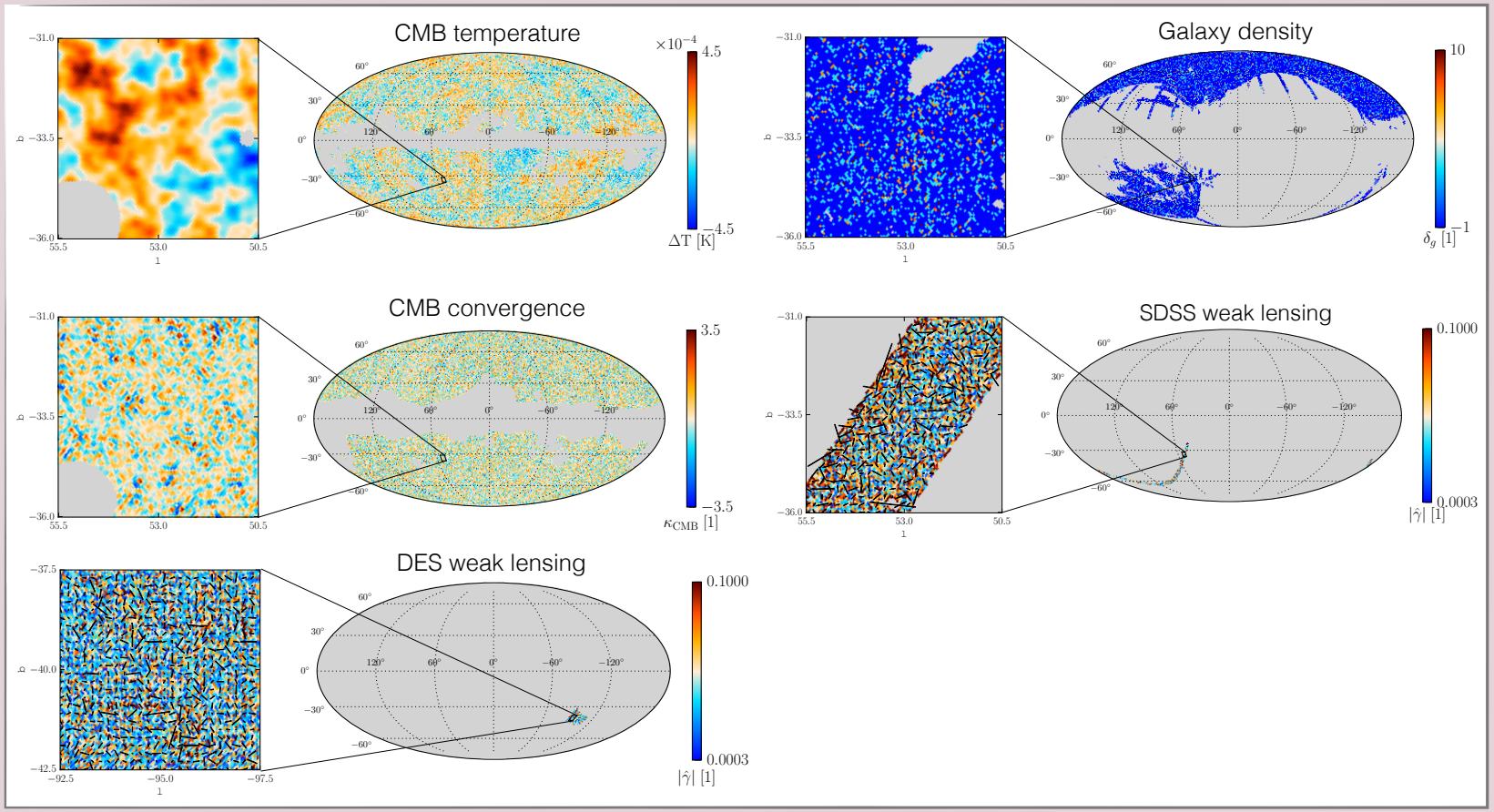

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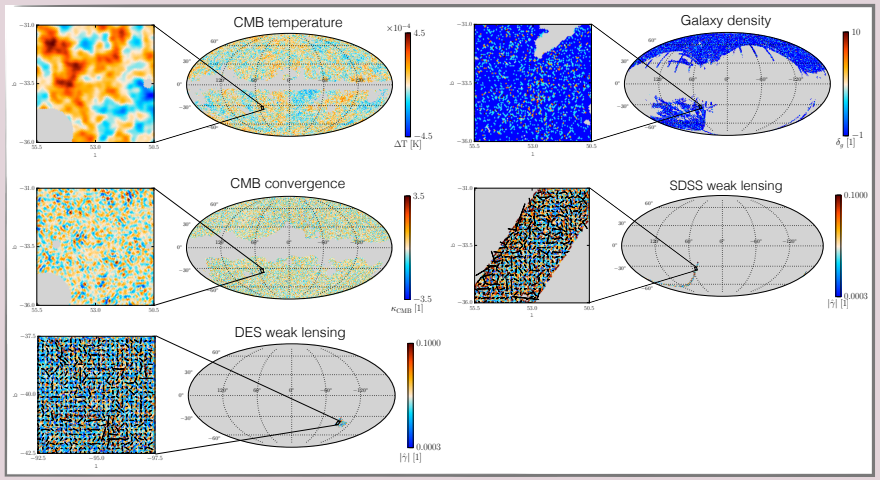

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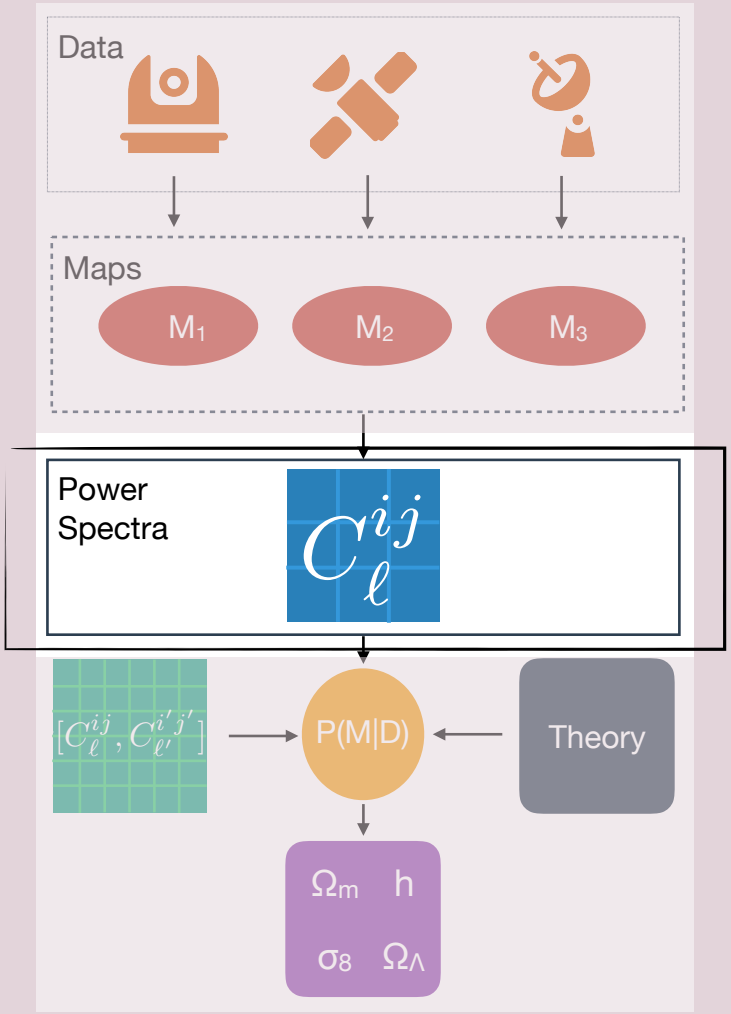

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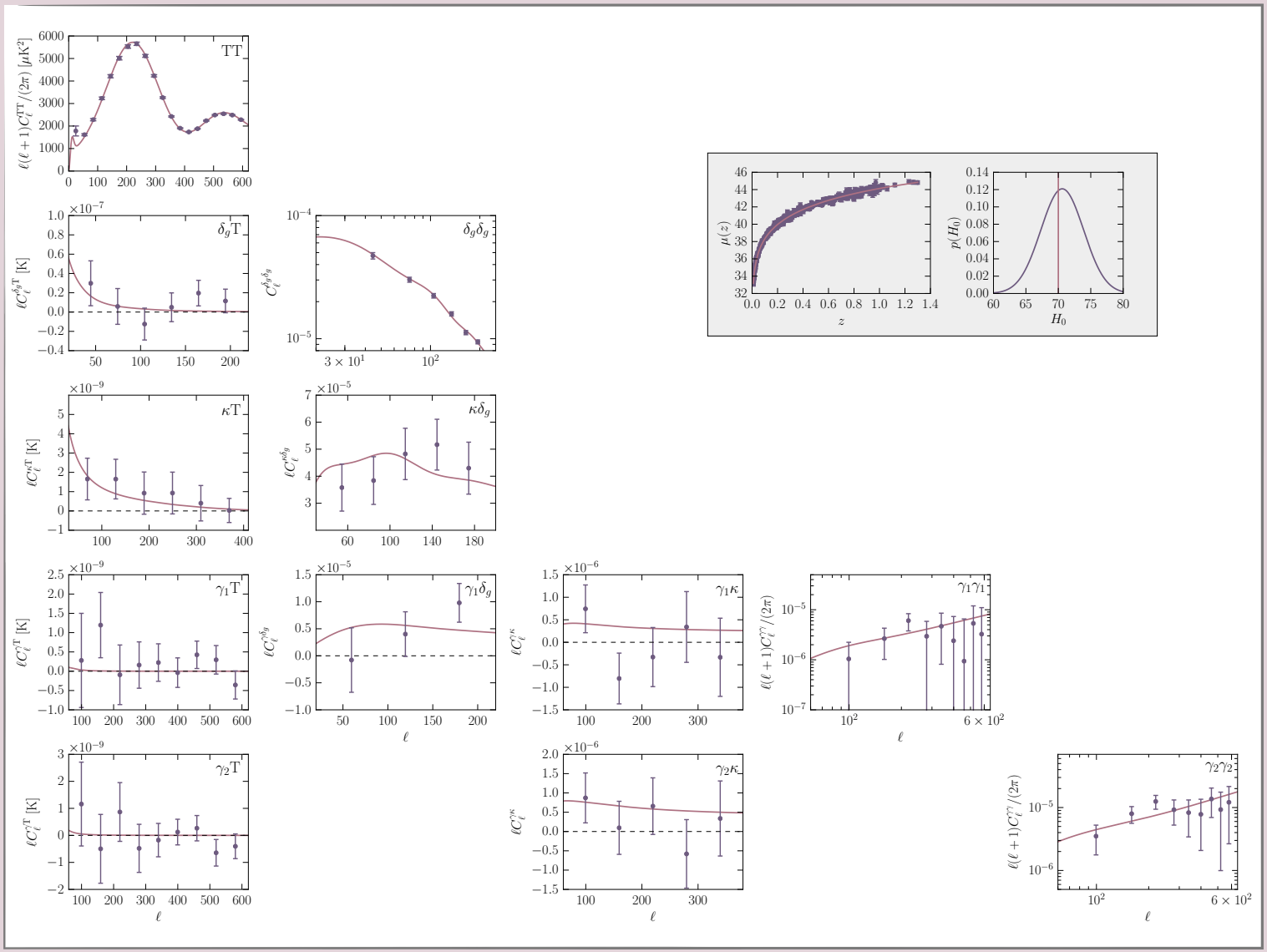

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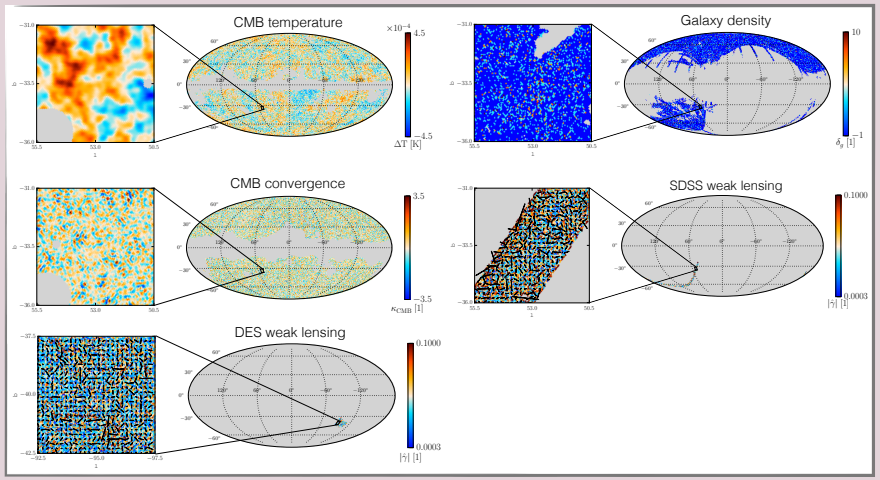

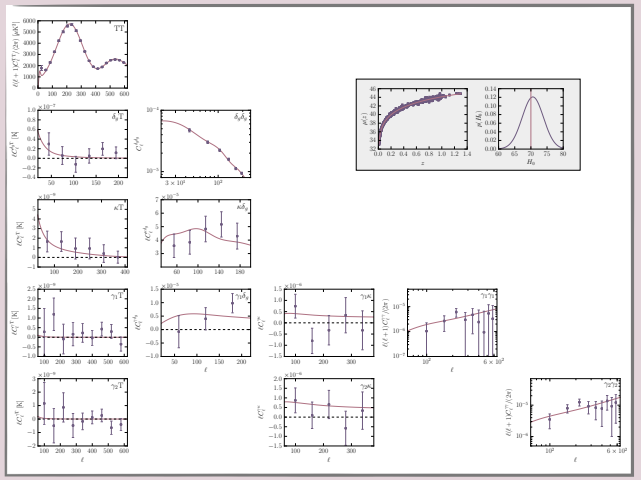

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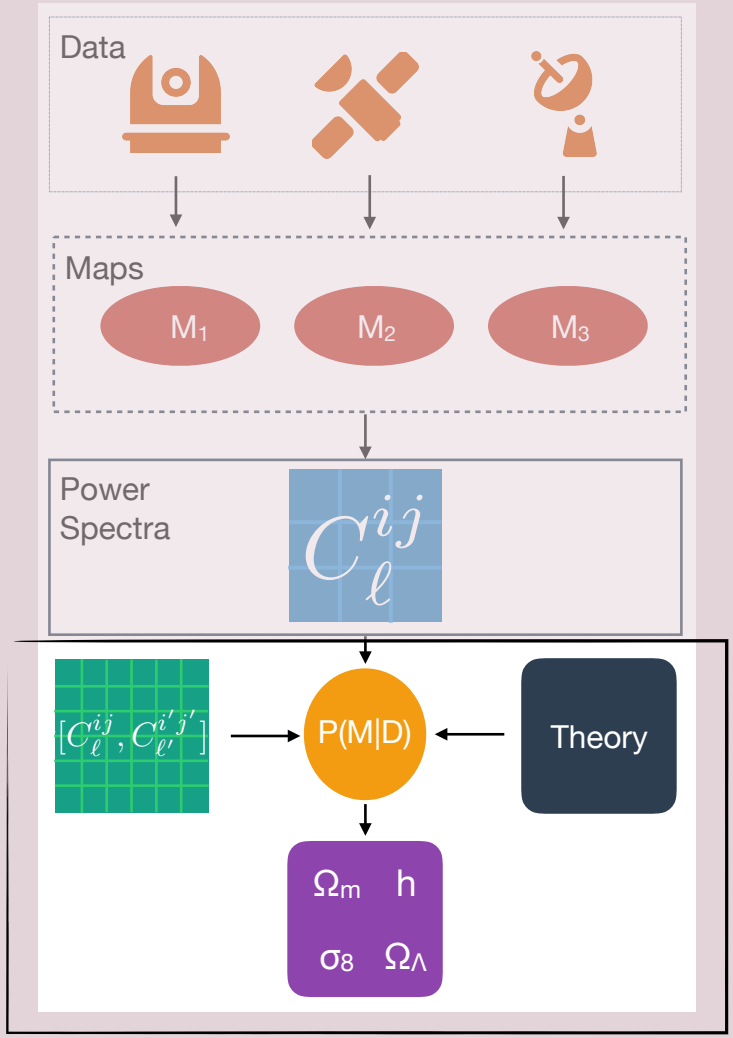

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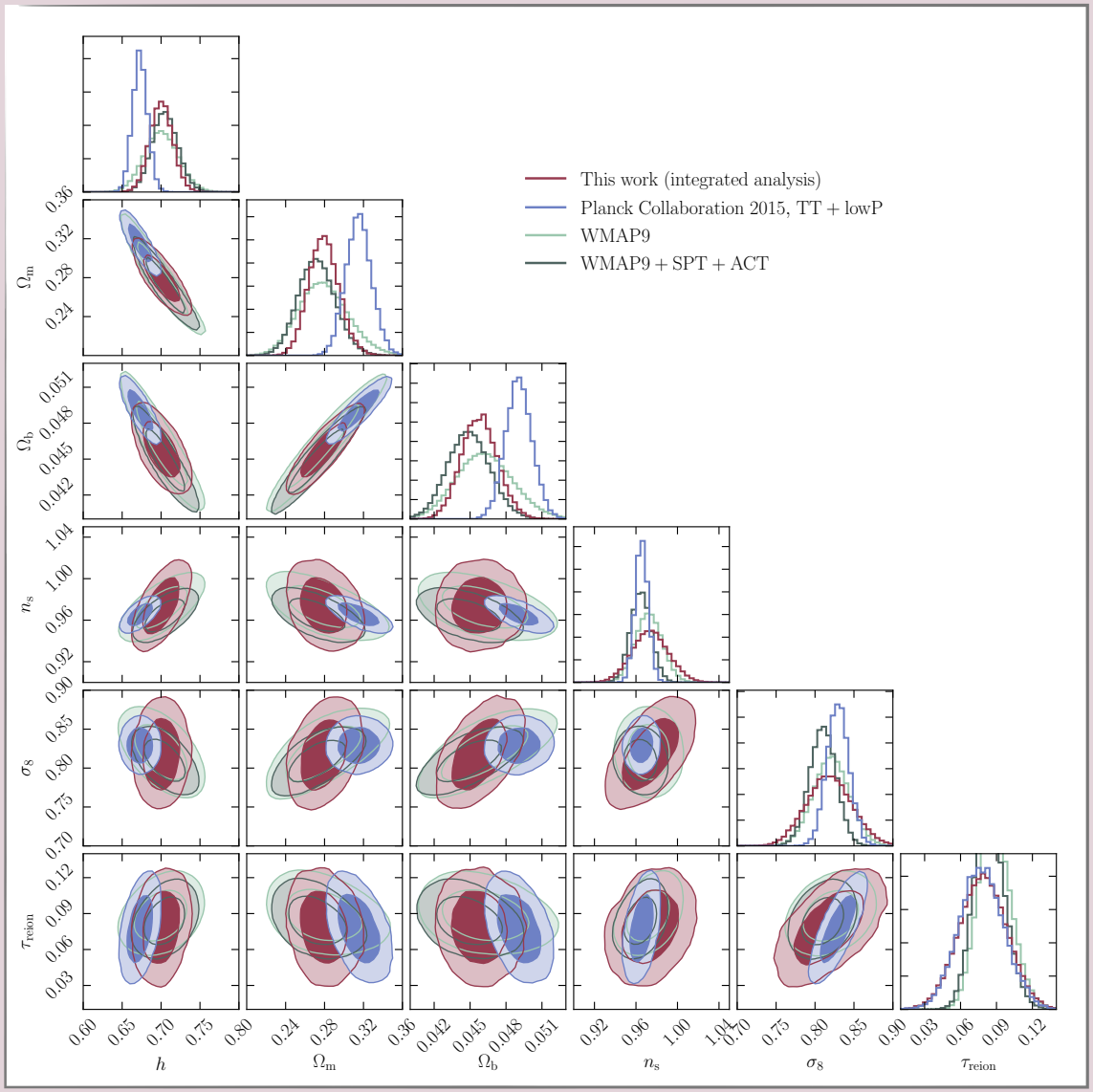

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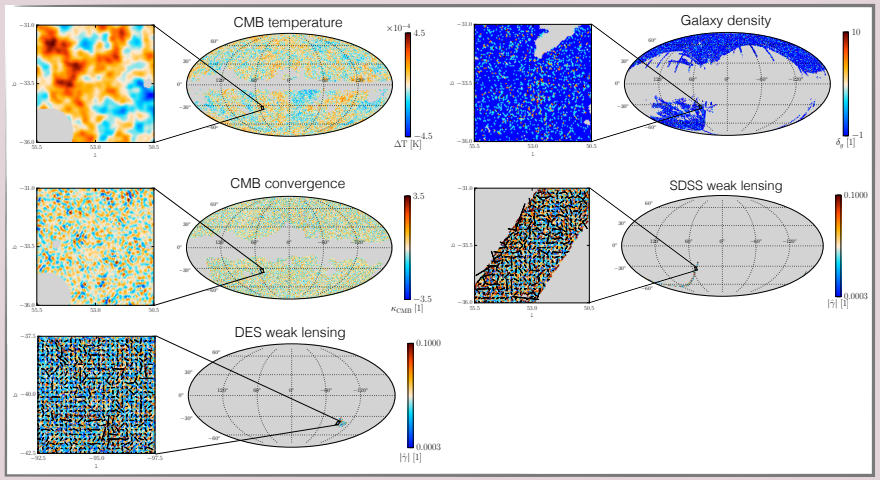
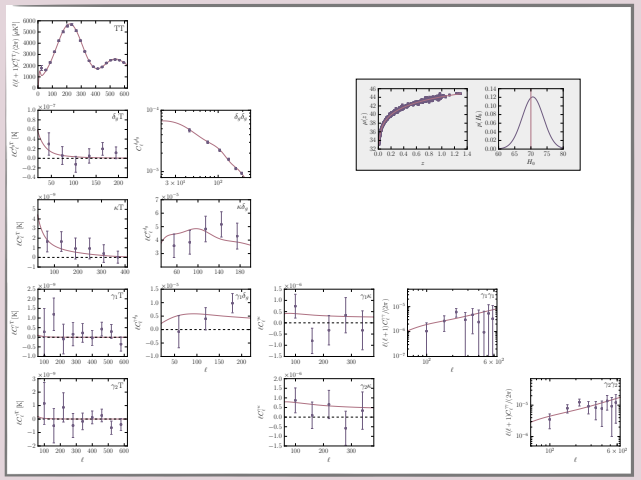
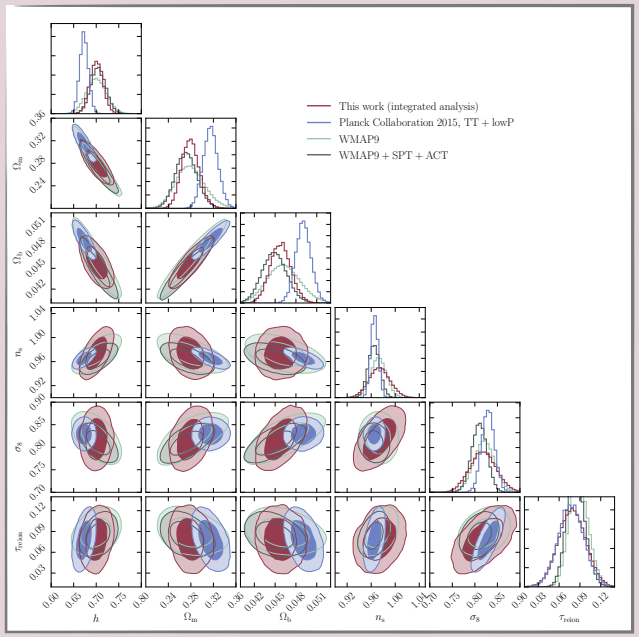






Nicola et al., 2016
Nicola et al., 2017a
Nicola et al., 2017b

Higgs inflation at the hilltop

Vera-Maria Enckell, Kari Enqvist,
Syksy Räsänen and **Eemeli Tomberg**

Stockholm 18.7.2017

eemeli.tomberg@helsinki.fi

Results

- We have done both analytical approximations and numerical simulations
  - Hilltop used as a starting point when constructing the potentials
- Predicted values:

	r	n_s
Tree-level	$12/N^2$	$1-2/N$
Hilltop	$< 3/N^2$	$< 1-2/N$
Hilltop, N=50	< 0.0012	< 0.96

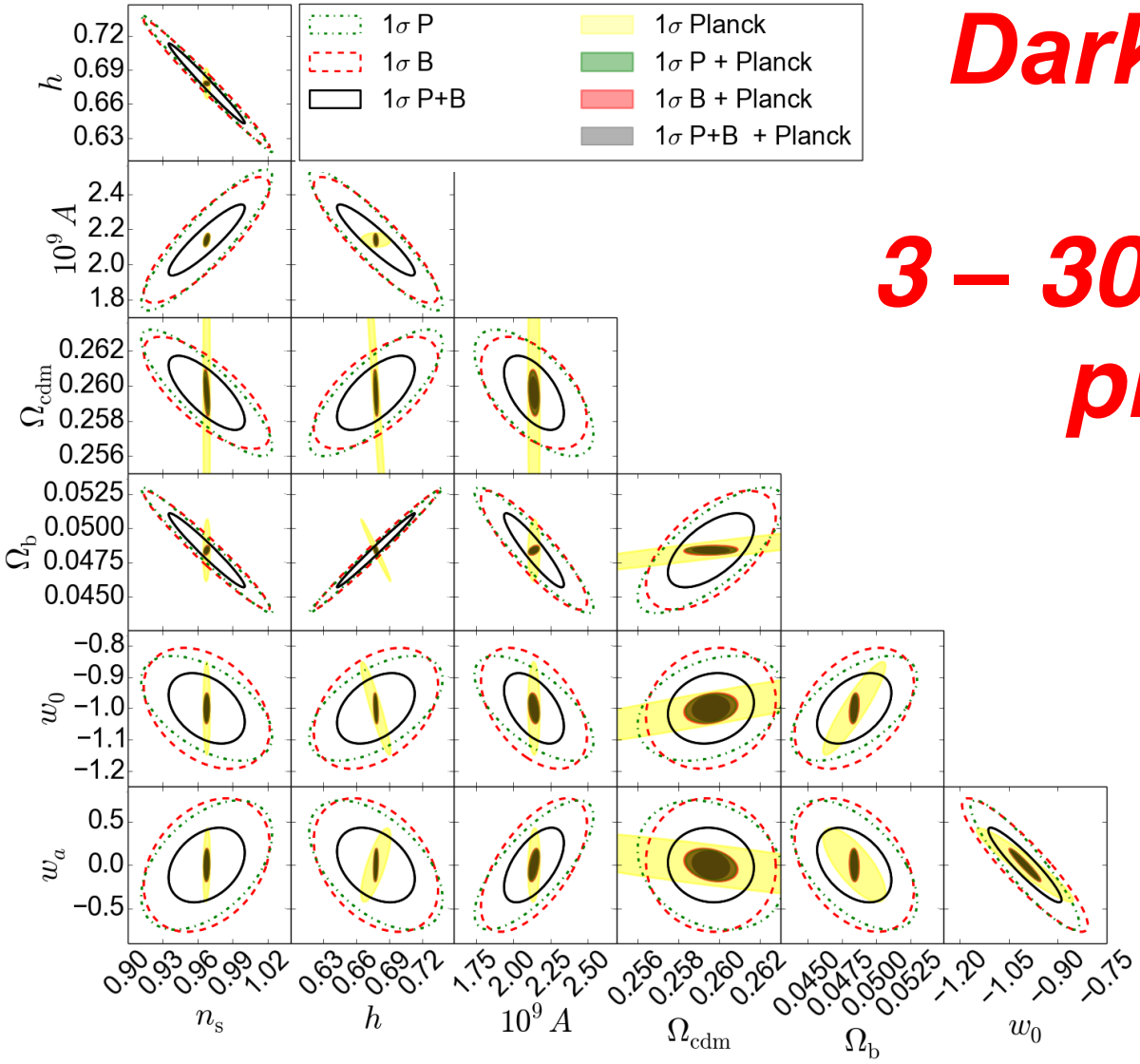
Victoria Yankelevich, Cristiano Porciani

Cosmology with the Euclid galaxy bispectrum

Argelander institute for Astronomy,
University of Bonn

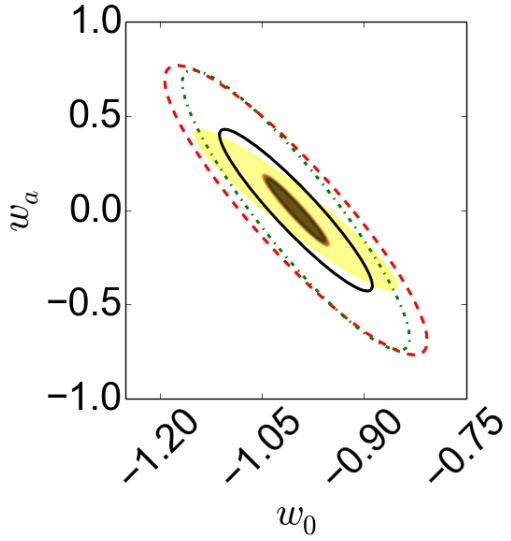
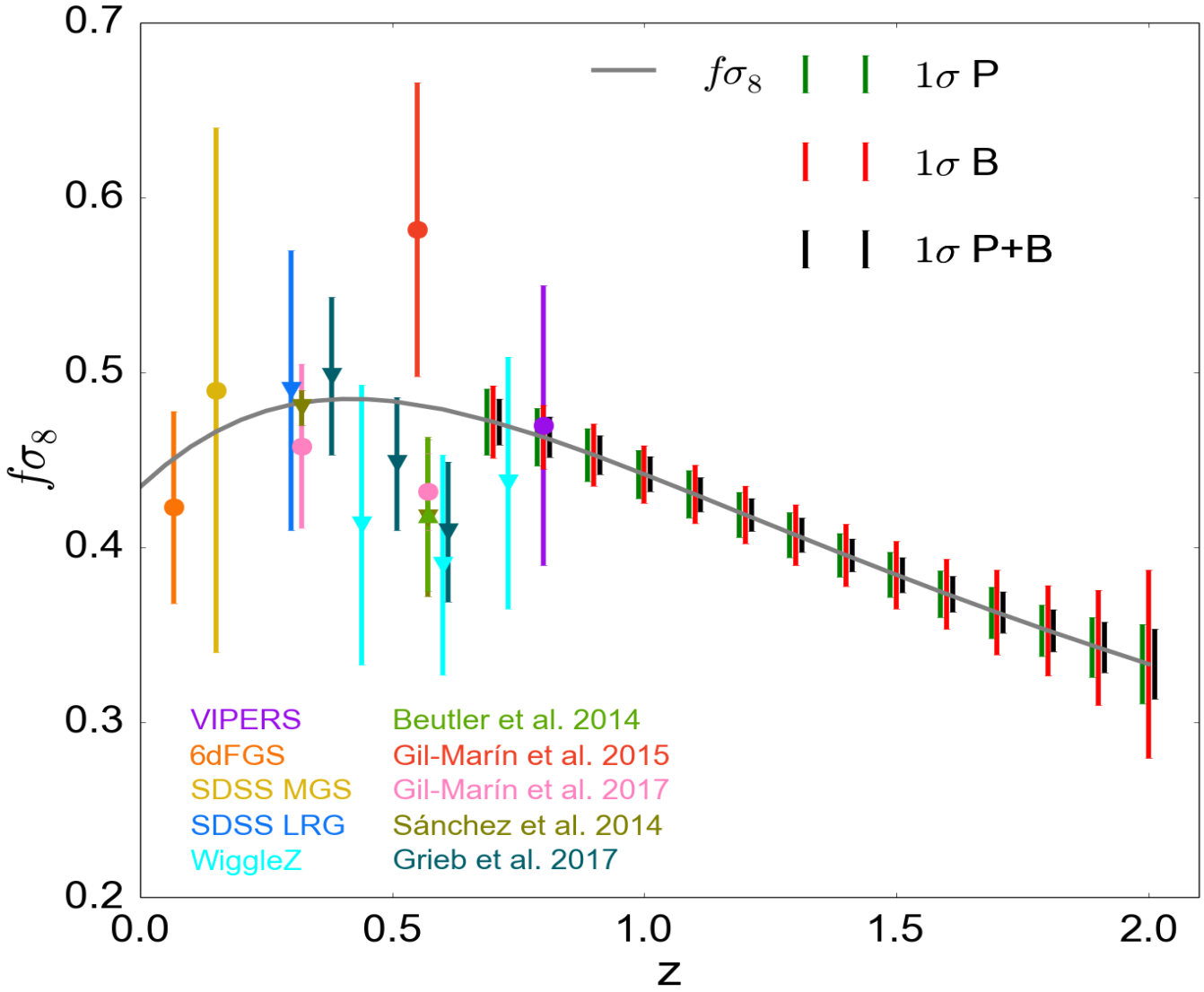
Advances in Theoretical Cosmology in Light of Data,
Nordita, 18.07.2017

Euclid-like forecast



Dark Energy…

3 – 30 times more precise!!!



ΛCDM *fixed cosmology*