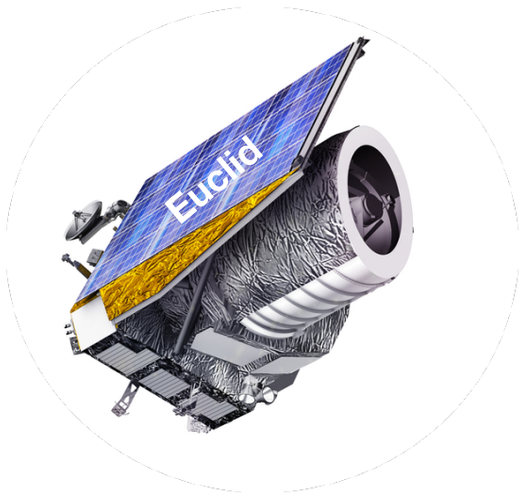
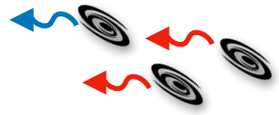
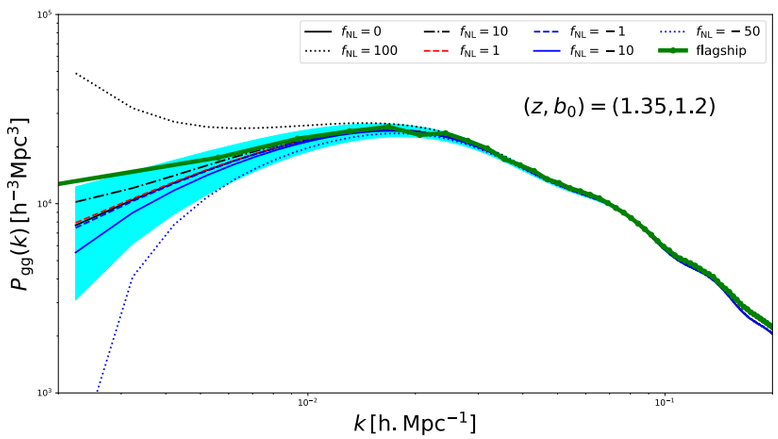
Observational Systematics of Local Primordial Non-Gaussianity with Euclid

Pierros Ntelis







GC-SWG: Additional Probe, OU-LE3

Aknowledgements:

A.J.Hawken, A.Pourtsidou, S.Camera, S. Avila, S.Escoffier, A.Tilquin, J.Zoubien, S.G.Beauchamp, D.Markovic, B.Granett, P.Monaco, T.Castro, E.Sefussatti, F. Rizzo, N.Hamaus, J.Koda et …

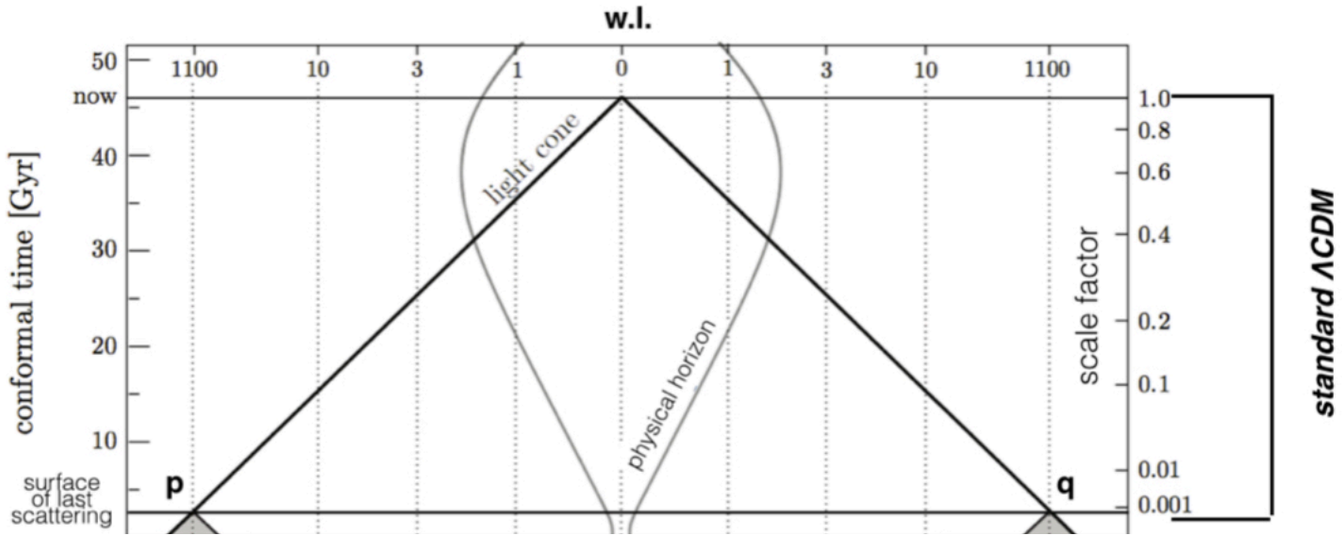
Outline

- **Physical Principles**
- **Current Status**
- **Observational Strategy**
- **Preliminary Results**
- **Conclusion and Outlook**

Obs. Syst. of Local Primordial Non-Gaussianity | Physical Principles

Inflation is needed for

- **large scale isotropy**
- **flatness problem**



Whatever the initial Value of Ω_k with time it drops to 0 during inflation

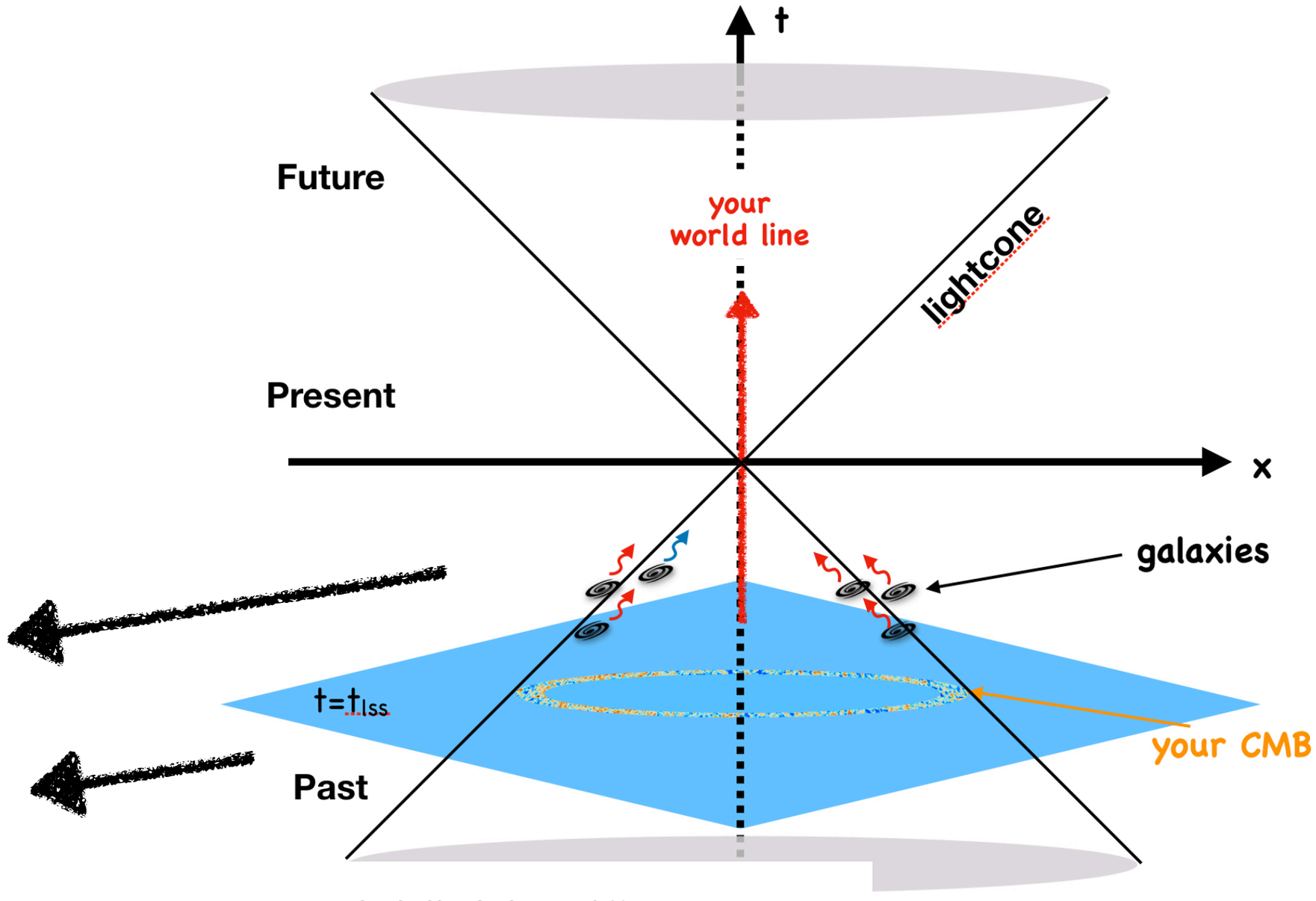
comoving distance [Gly]

Conformal time , η as function of comoving distance resolving the horizon problem.
[Image taken and remodified by Baumann [6]]

Obs. Syst. of Local Primordial Non-Gaussianity | Physical Principles

Inflation Is Imprinted In LSS

Primordial Non-Gaussianity Signal



Inspired by F.Leclercq et al. 2014

1D simple non-gaussian signal example

Decompose the signal of a any Gaussian field into:

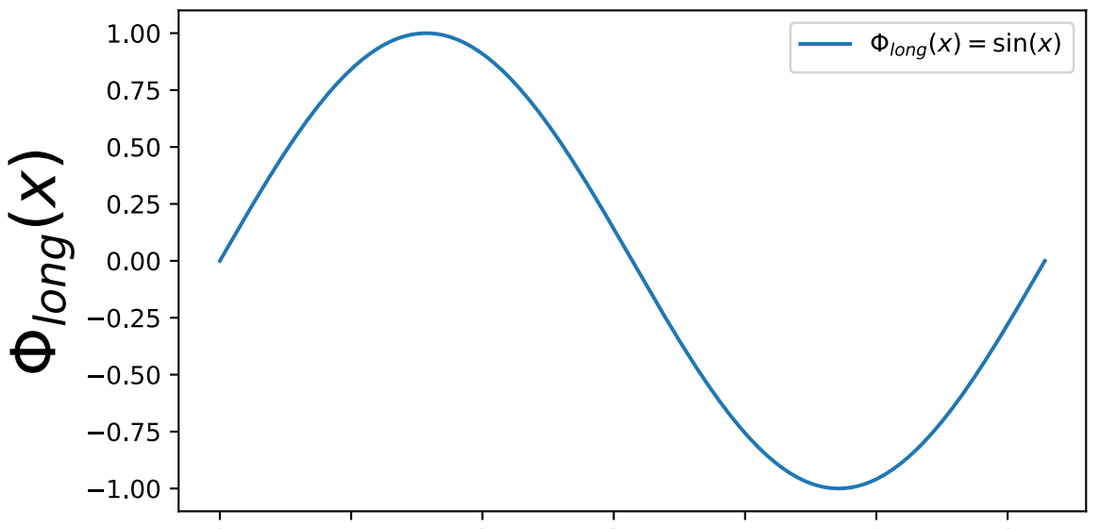
$$\Phi_G(x) = \Phi_{short}(x) + \Phi_{long}(x)$$

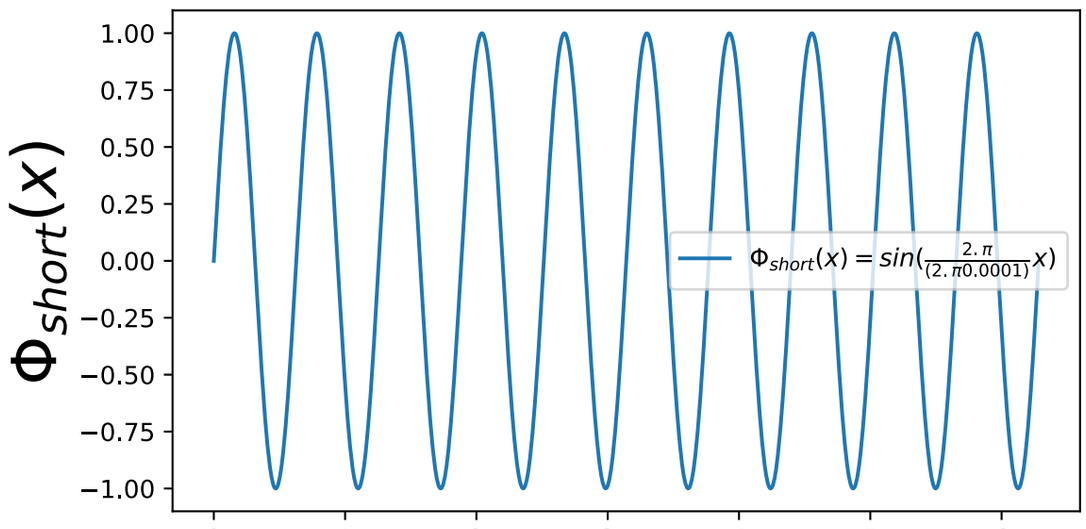
Then the Non-Gaussian field is described by:

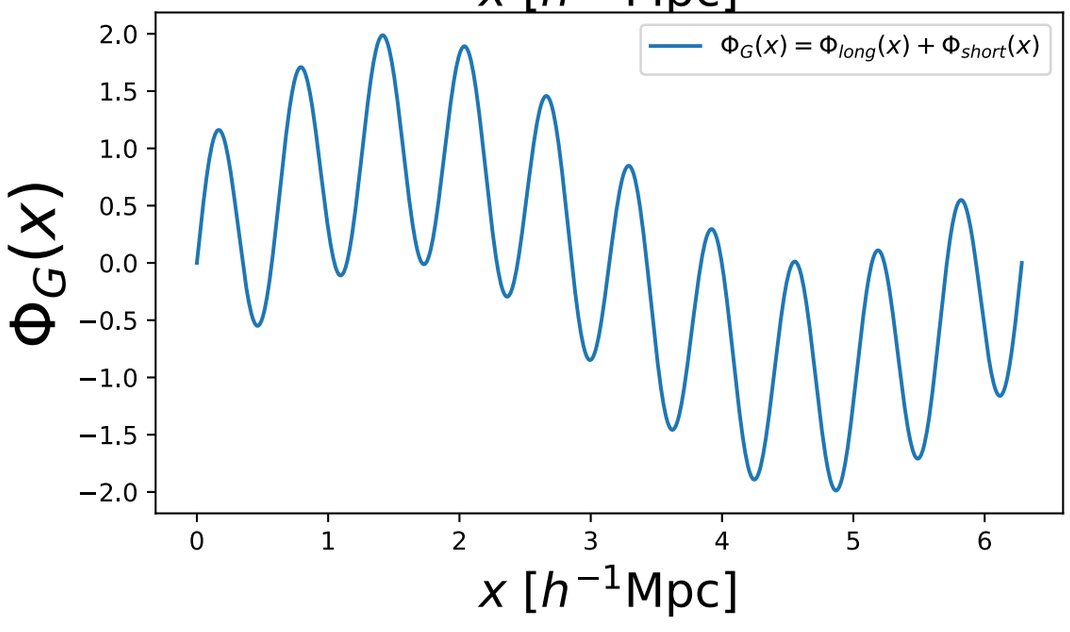
$$\Phi_{NG}(x) = \Phi_G(x) + f_{\rm NL}^{\rm loc}\Phi_G^2(x)$$

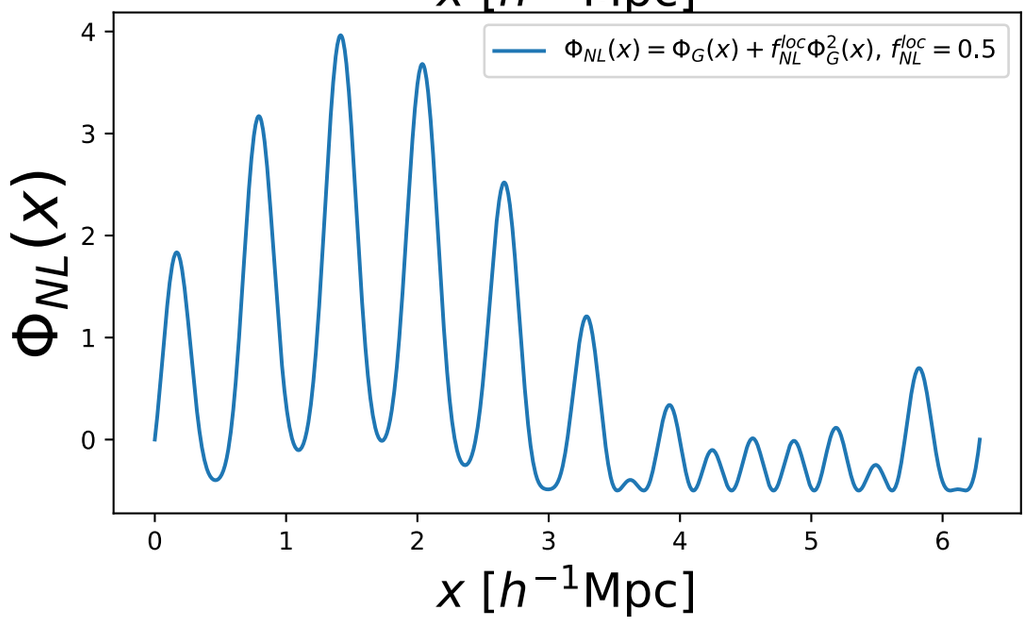
f_{NL}^{loc} : local, non-linearity parameter of Primordial Non-Gaussianity

Obs. Syst. of Local Primordial Non-Gaussianity | Physical Principles

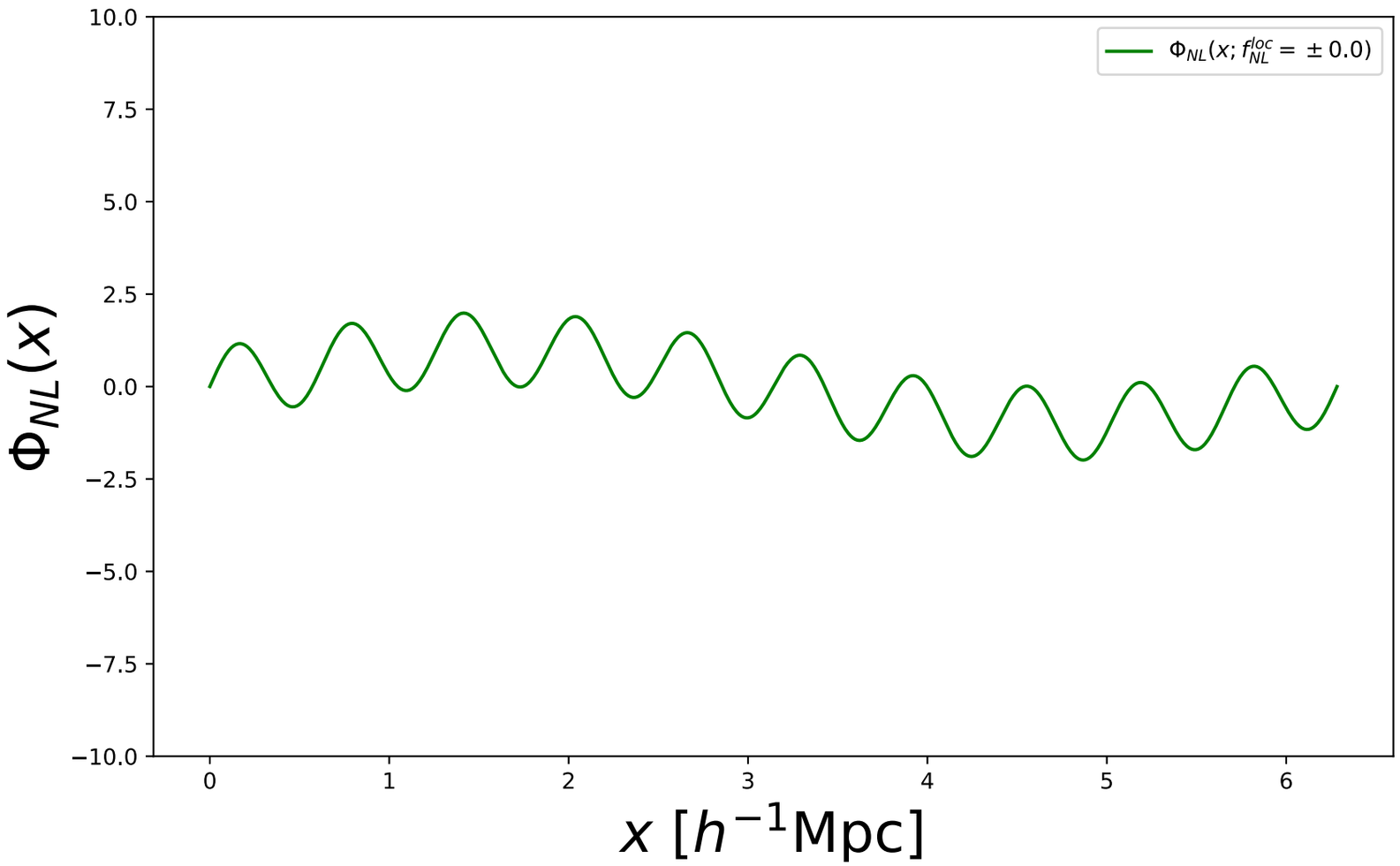




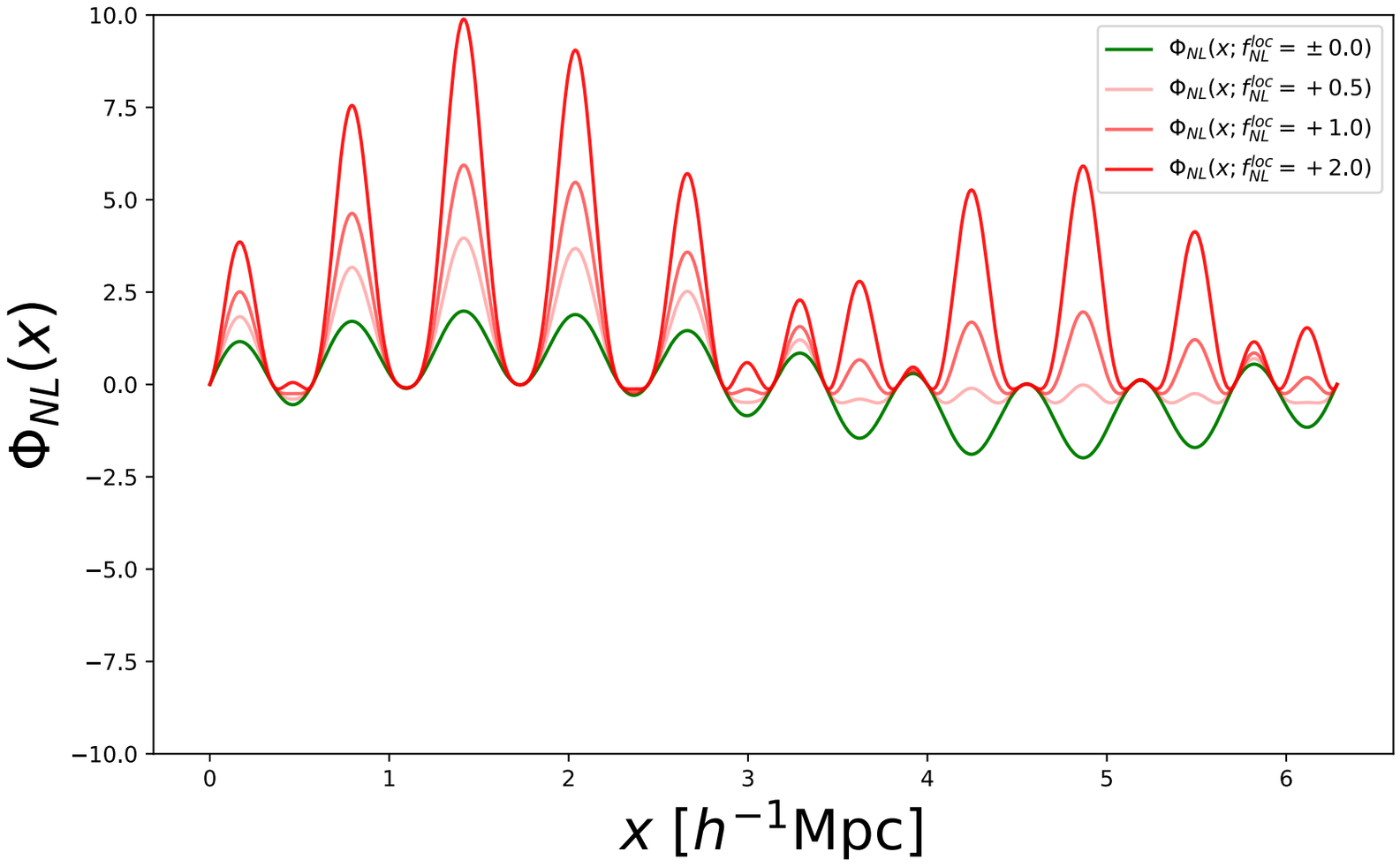




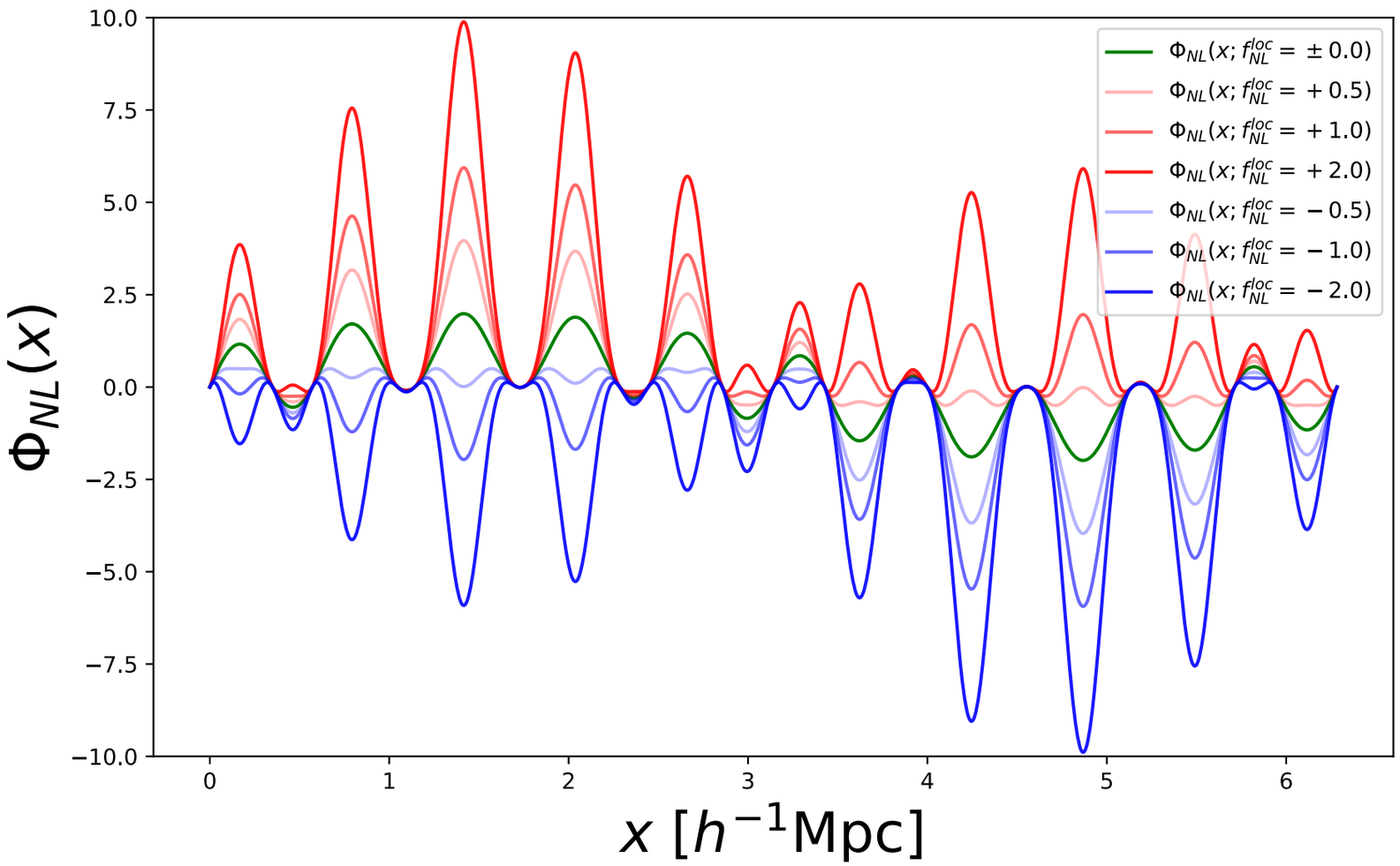
1D simple non-gaussian signal example



Obs. Syst. of Local Primordial Non-Gaussianity | Physical Principles



Obs. Syst. of Local Primordial Non-Gaussianity | Physical Principles



- Realistic signal: is not sinusodial
  is a function that fluctuates around a gaussian signal

- Expectation:
  Primordial Non-Gaussian Signal will be imprinted to the late-time universe

- The late time universe has also non-gaussian behaviour
  due to non-linear gravity physics, [A. Slosar et al 2008 Ansatz model]

Outline

- Physical Principles
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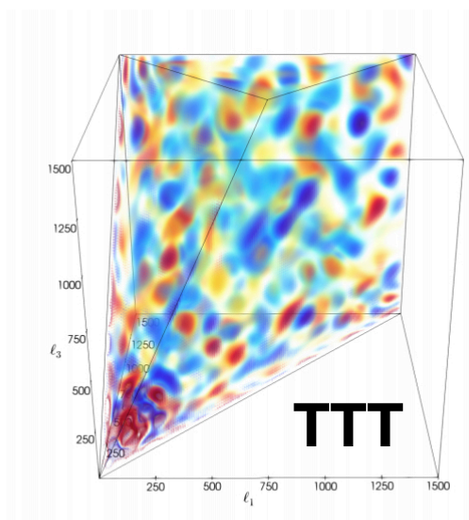
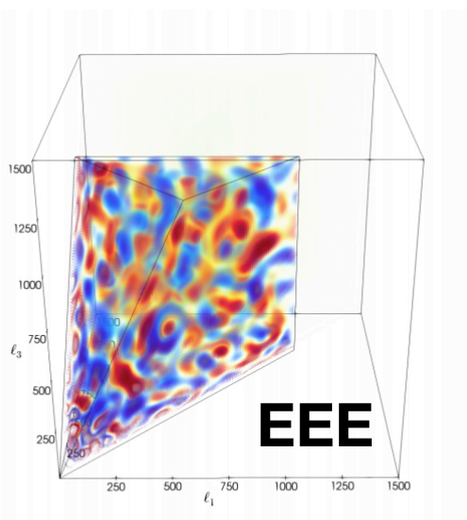
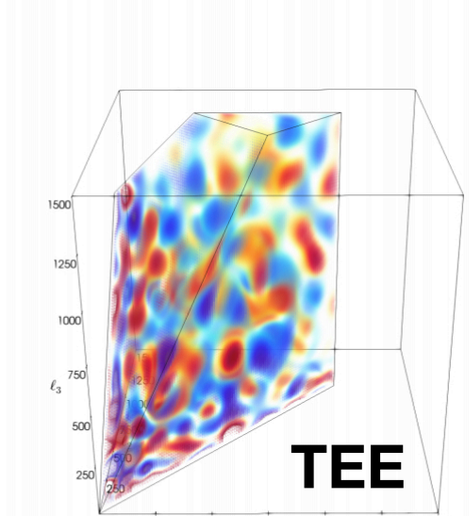
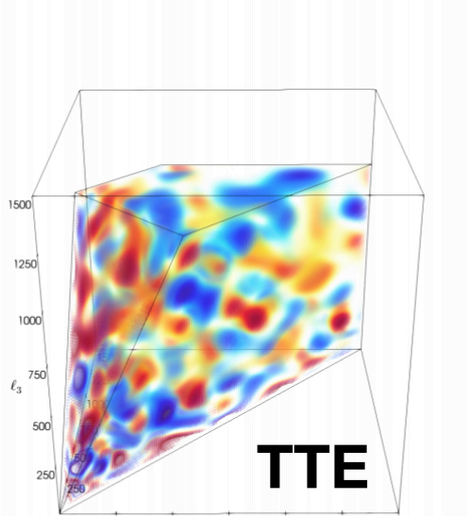
Obs. Syst. of Local Primordial Non-Gaussianity | Current Status

But Best Constrains from CMB









Planck 2018

Angular Bispectra: B(l1,l2,l3)

1. $f_{NL}^{loc} = 0.5 \pm 5.0$
2. $f_{NL}^{equi} = -4 \pm 43$
3. $f_{NL}^{ortho} = -26 \pm 21$

SDSS eBOSS QSO Pk 2019

1. $-26 < f_{NL}^{loc} < 11$

Predictions from Clustering >2020

$\sigma_{f_{NL}} \simeq 5, 0.3$ at 68% C.L

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Obs. Syst. of Local Primordial Non-Gaussianity | Obs. Strategy

CMB -> Angular Power, Bispectra
Cross Spectra

Cross spectra with galaxies

LSS -> Power Spectra, Bispectra
Cross Spectra

Cross Spectra with CMB
or different tracers

LSS -> Power Spectra

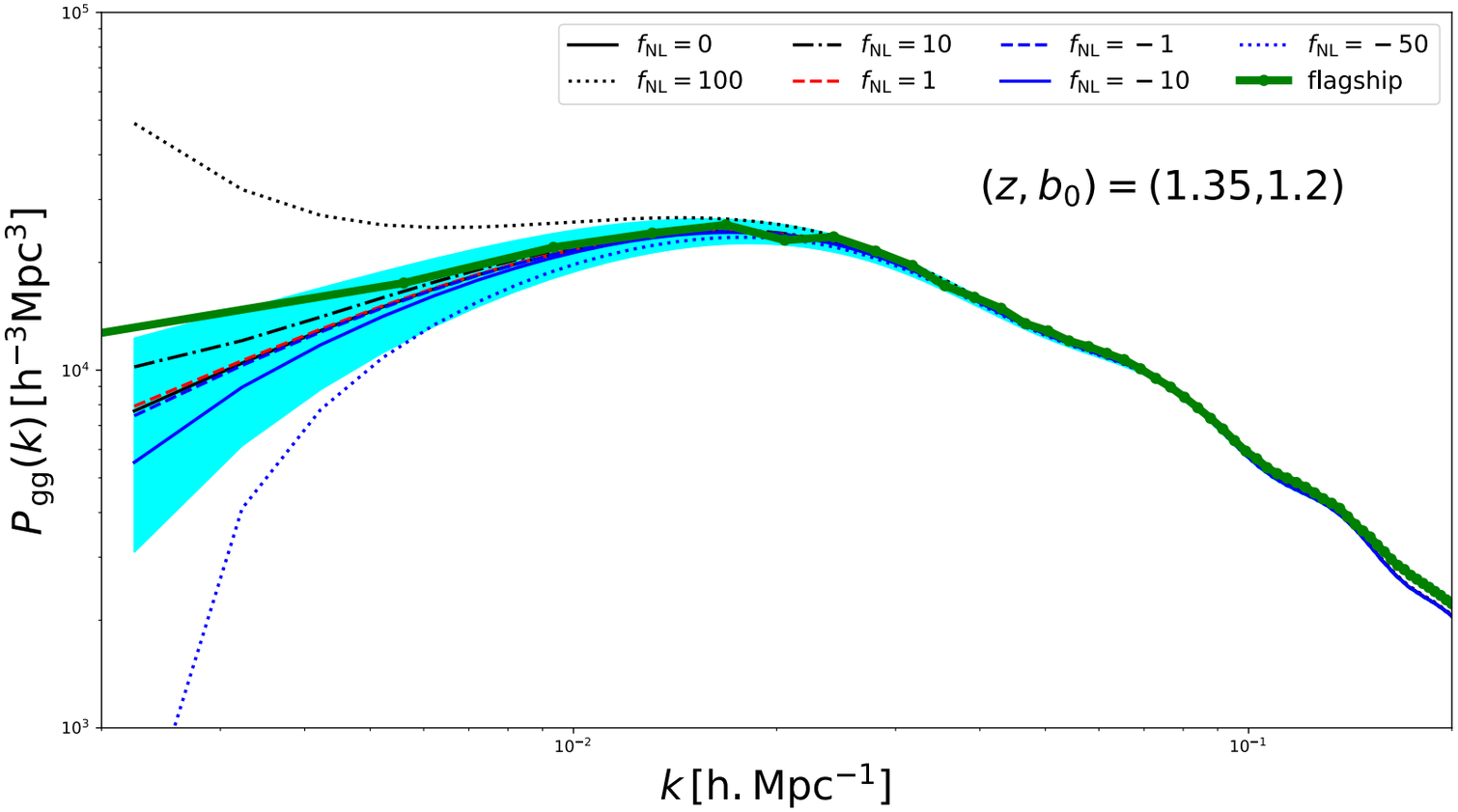
Obs. Syst. of Local Primordial Non-Gaussianity | Obs. Strategy

Sim

Area = 5000deg2

- $\log_{10}(f_{H\alpha 1}) > -16$
- Gal 20838990
- Ran 1041949950

- Pk-obs, no pypelid
- MAS = TSC
- Pk-th, not convolved w/ Window F.



Theory

Shaded Area = 15000 deg2

$$P_{gg}(k,z) = \left[b_g(z;b_0) + \mathcal{C}_{ng}(k,z;b_0,f_{\rm NL})\right]^2 D_g^2(z) P_m(k,z=0)$$

$$\mathcal{C}_{ng}(k,z;b_0,f_{NL}) = 3 f_{NL} \frac{\Omega_{m,0}\delta_c H_0^2}{k^2 T_m^2(k) D_g(z) c^2} \left[b_g(z;b_0) - p\right]$$

p = **1 (halo mass)**, 1.6 (recent merger)

[A. Slosar et al 2008 Ansatz model]

- **At large scales, P(k) is dominated by:**
  - **Cosmic Variance**
  - **Survey Systematics**
  - **Pk-estimators**

Obs. Syst. of Local Primordial Non-Gaussianity | Obs. Strategy

pypelid

- Zodiacal light
- Milky Way Extinction
- Sky brightness
- Stellar density
- Spectro-Photometric 0-point calibration

- Depth of the survey
- Focal plane effects

- Obscuration effects
  - Contamination from line misidentification (same target)
    - Other lines look like Ha1 and the z-estimate is wrong
    - Correct P(k,μ) with priors on the lines from the Deep Field
  - Confusion from overlapping spectra (different target)
    - Stellar or Galactic Occultation (simple model)

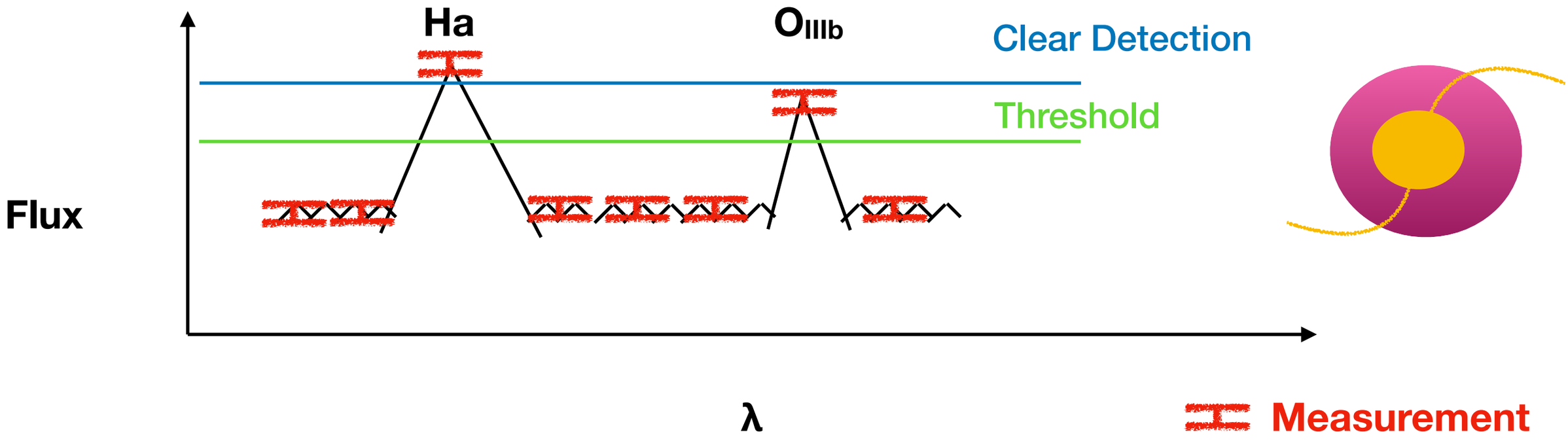
- Random error -> significant on large k
  - Noise, template fitting
- RSD (not yet in flagship 1.5.X) -> scale independent on large k

From
Systematic Error Budget
Document

Simulate with pypelid

Astronomy 101: Obscuration effects

Suppose line-Identification on Flux



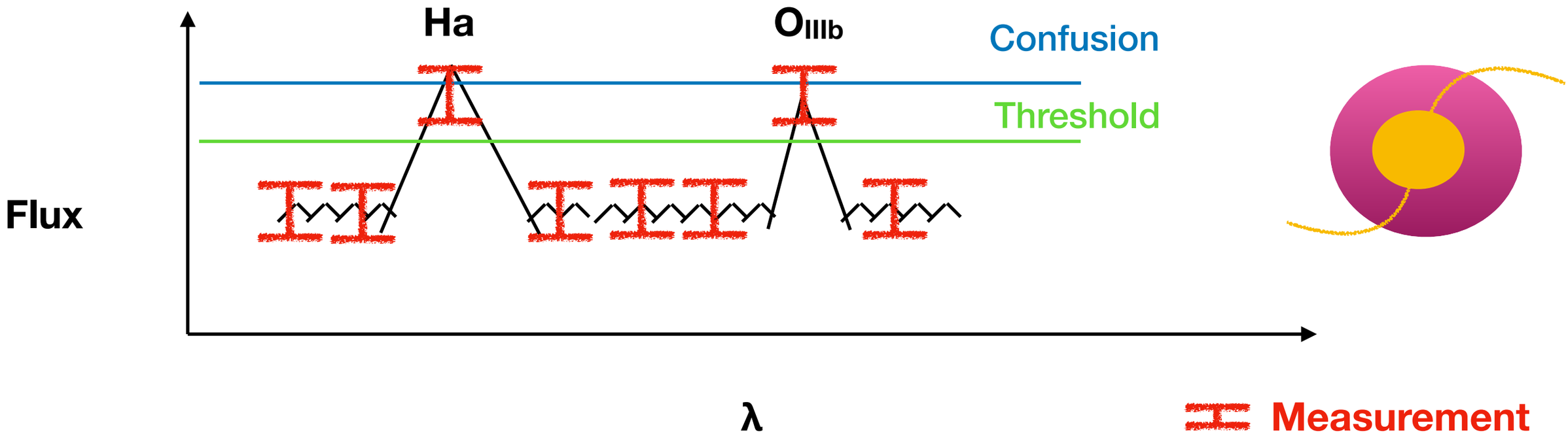
Analytical Modelling for these effects:

Pullen, A. R., C. M. Hirata, O. Doré, et al. 2015
Wong, K., A. Pullen, and S. Ho 2016

Astronomy 101: Obscuration effects

Suppose line-Identification on Flux

Line misidentification: confusion of Hα with O_{IIIb}



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Due to noisy instrument
noisy flux measurement

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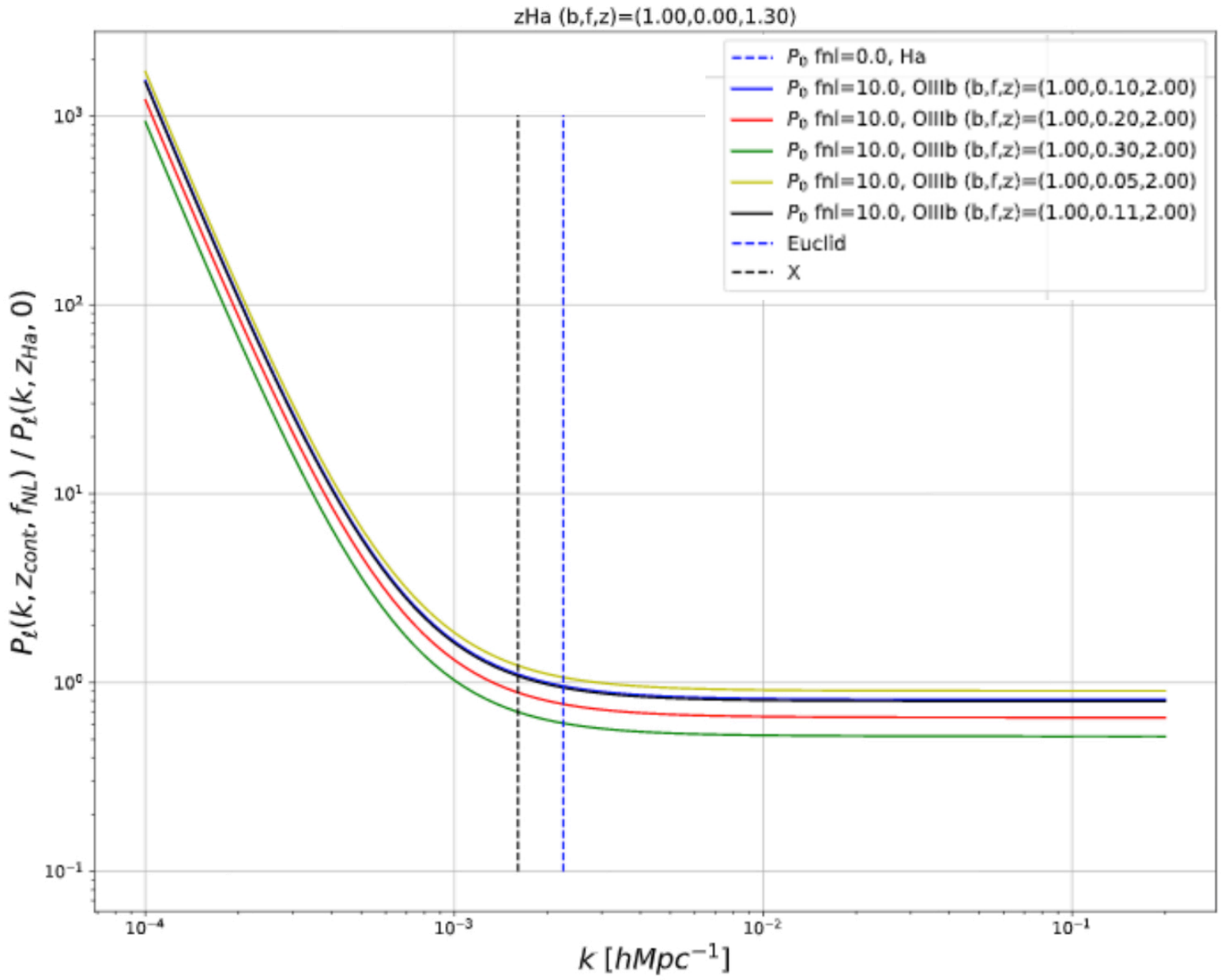
Obs. Syst. of Local Primordial Non-Gaussianity | Preliminary Results

Power Spectra Monopole with OIIIb contamination drops in percent with respect to fiducial one

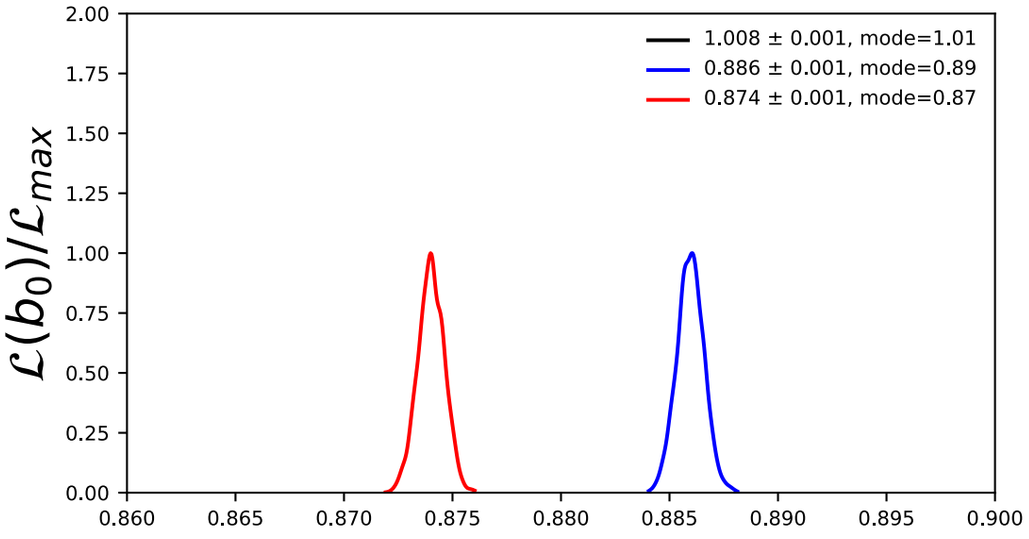
Increase of the signal due to fNL

sub-% k-dependence due to contamination

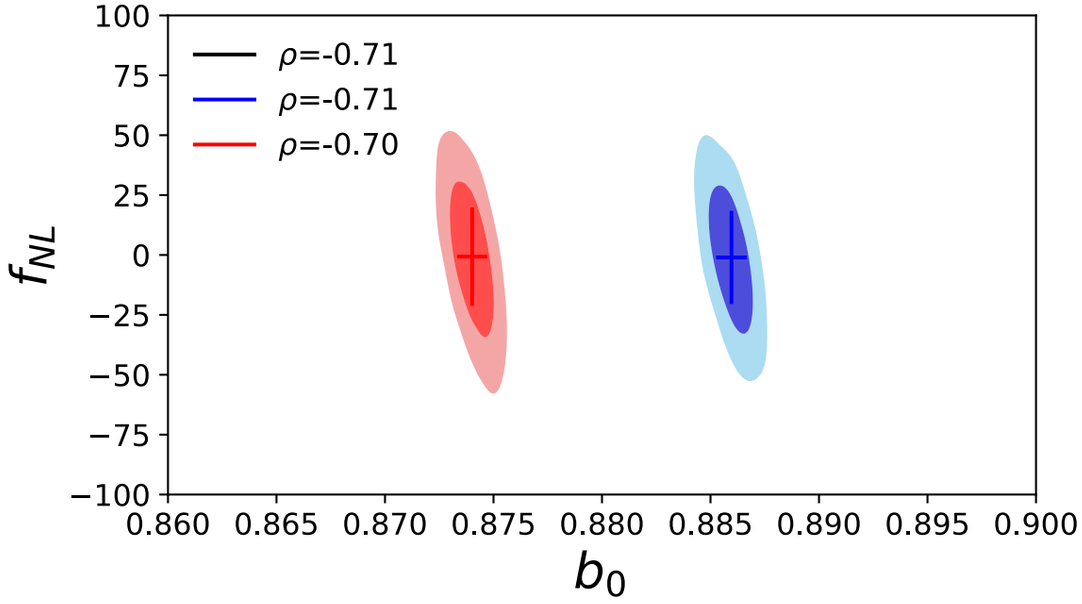


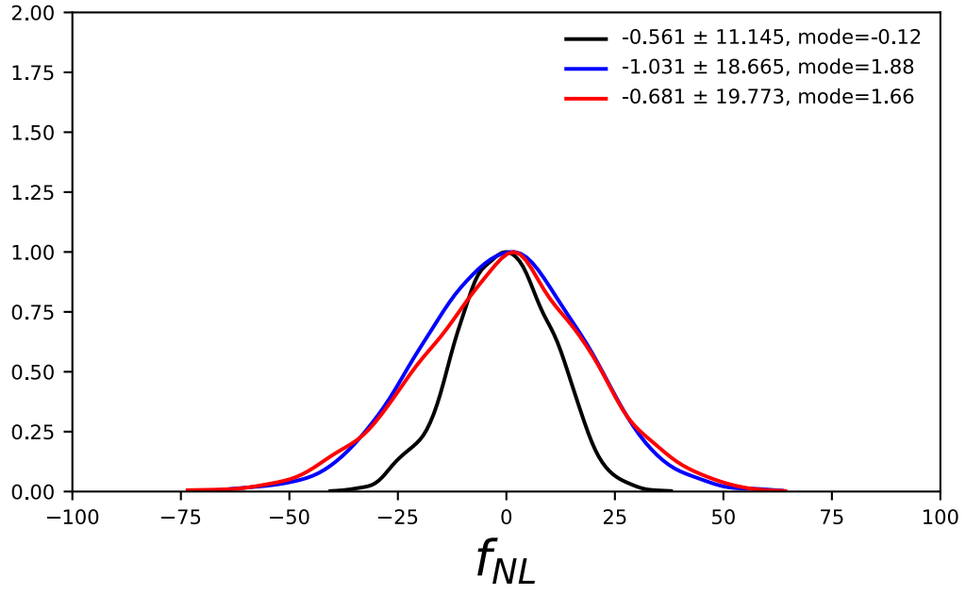
Obs. Syst. of Local Primordial Non-Gaussianity | Preliminary Results

$$\chi^2_{f_i}(b_0, f_{NL}) = \sum_{k=k_{min(\Omega_{Euclid})=0.0023}}^{0.2} \sum_{\ell,\ell'=0} \left[P^{\mathrm{OIIIb}, f_{NL}=0}_{\chi,f_i,\ell}(k; z_{H\alpha}) - P_{\chi,\ell}(k; z_{H\alpha}; b_0, f_{NL}) \right]^2 / \delta P^2_{\chi,\ell}(k; z_{H\alpha})$$



Ha, $f_{NL,TL}$=0.0 $\chi^2 \pm \sqrt{2ndf}$=0.00±10.68 ,ndf=57.00
OIIIb f_i=0.10, $f_{NL,TL}$=0.0 $\chi^2 \pm \sqrt{2ndf}$=0.01±10.68 ,ndf=57.00
OIIIb f_i=0.11, $f_{NL,TL}$=0.0 $\chi^2 \pm \sqrt{2ndf}$=0.02±10.68 ,ndf=57.00





Assuming error does not change
-> Line Misidentification increases the Error on fNLloc

Outline

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Conclusion and Outlook

- Line Misidentification Important
  - on Large Scale Pk Multiples
  - fNLloc

- Improve Pk-code

- Use Current Code on Flagship

- Implement more sophisticated Line Misidentification

- Expect non-official code for cross correlations

Obs. Syst. of Local Primordial Non-Gaussianity

Thank you for your attention

Aknowledgements:

A.J.Hawken, A.Pourtsidou, S.Camera, S. Avila, S.Escoffier, A.Tilquin, J.Zoubien, S.G.Beauchamp, D.Markovic, B.Granett, P.Monaco, T.Castro, E.Sefussatti, F. Rizzo, N.Hamaus, J.Koda et …

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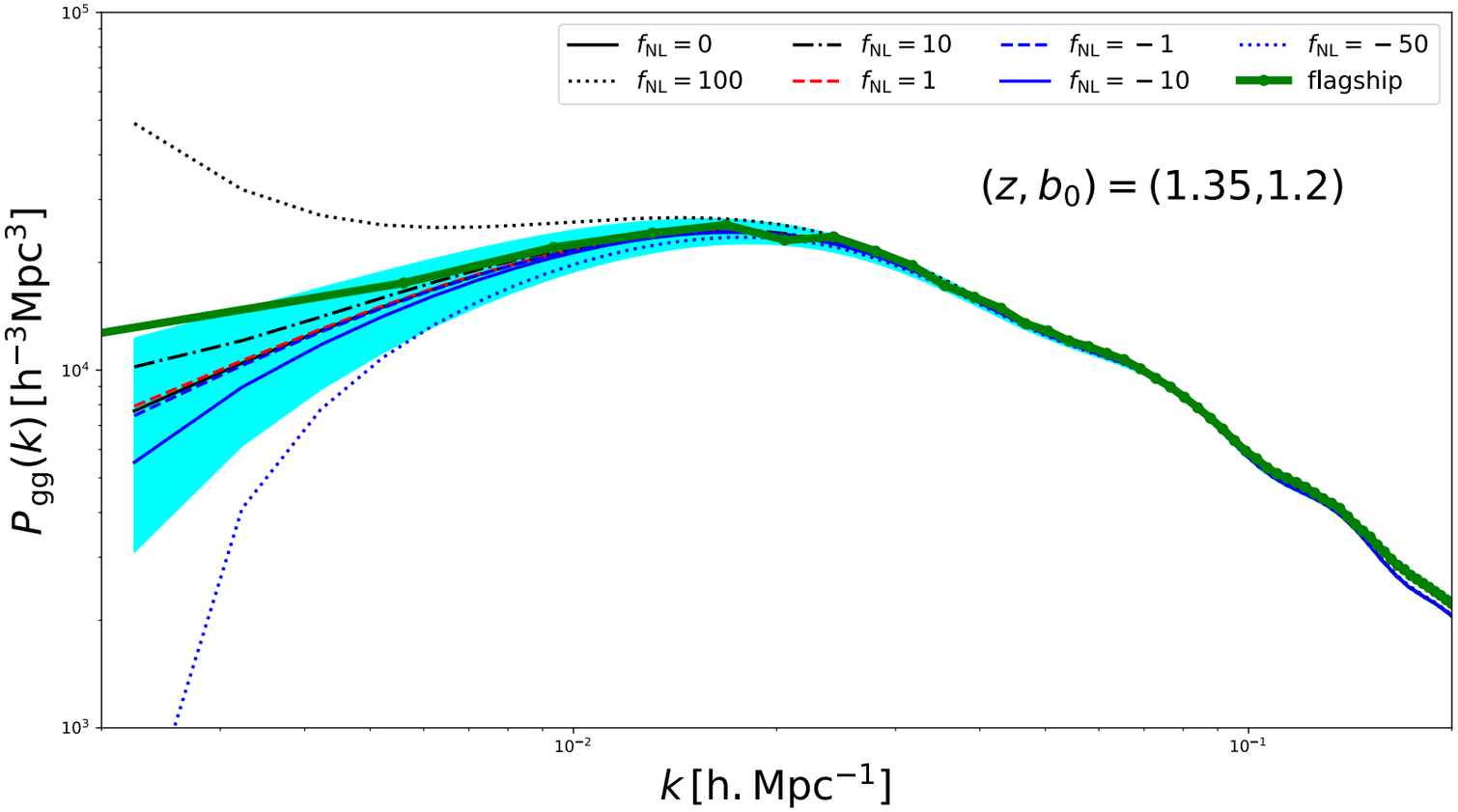

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$$C_{ng}(k,z;f_{NL}) = 3 f_{NL} \frac{\Omega_{m,0}\delta_{crit}H_0^2}{k^2 T_m^2(k) D_g(z) c^2}\,[b_g(z) - p]$$

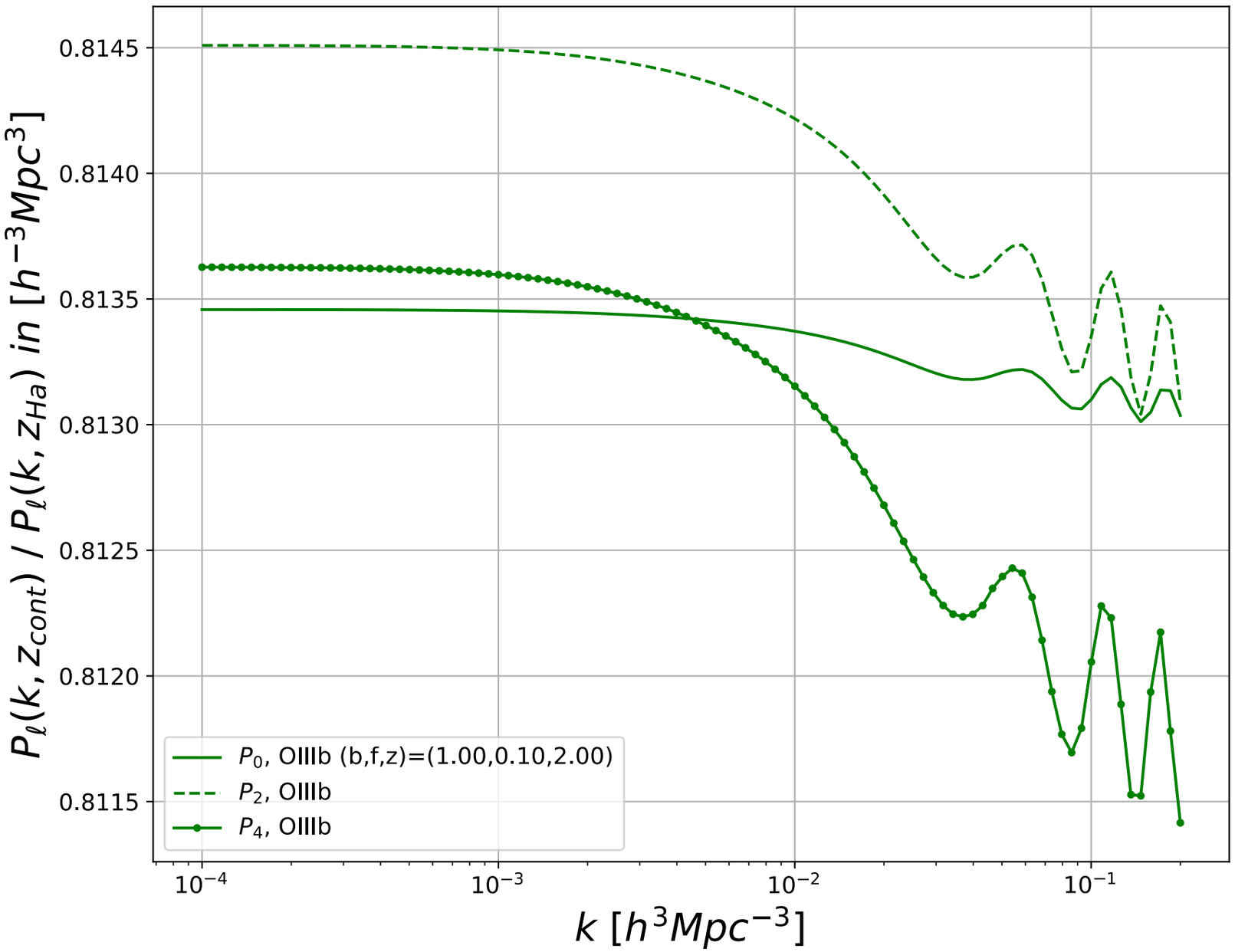
$$\delta P_{gg} = \sqrt{\frac{2(2\pi)^3}{V_{sur}(z)} \frac{1}{(4\pi k^2 * \Delta k)}} P_{gg}(z,k,b_0)$$

$$b_g(z;b_0) = b_0\sqrt{1+z}$$

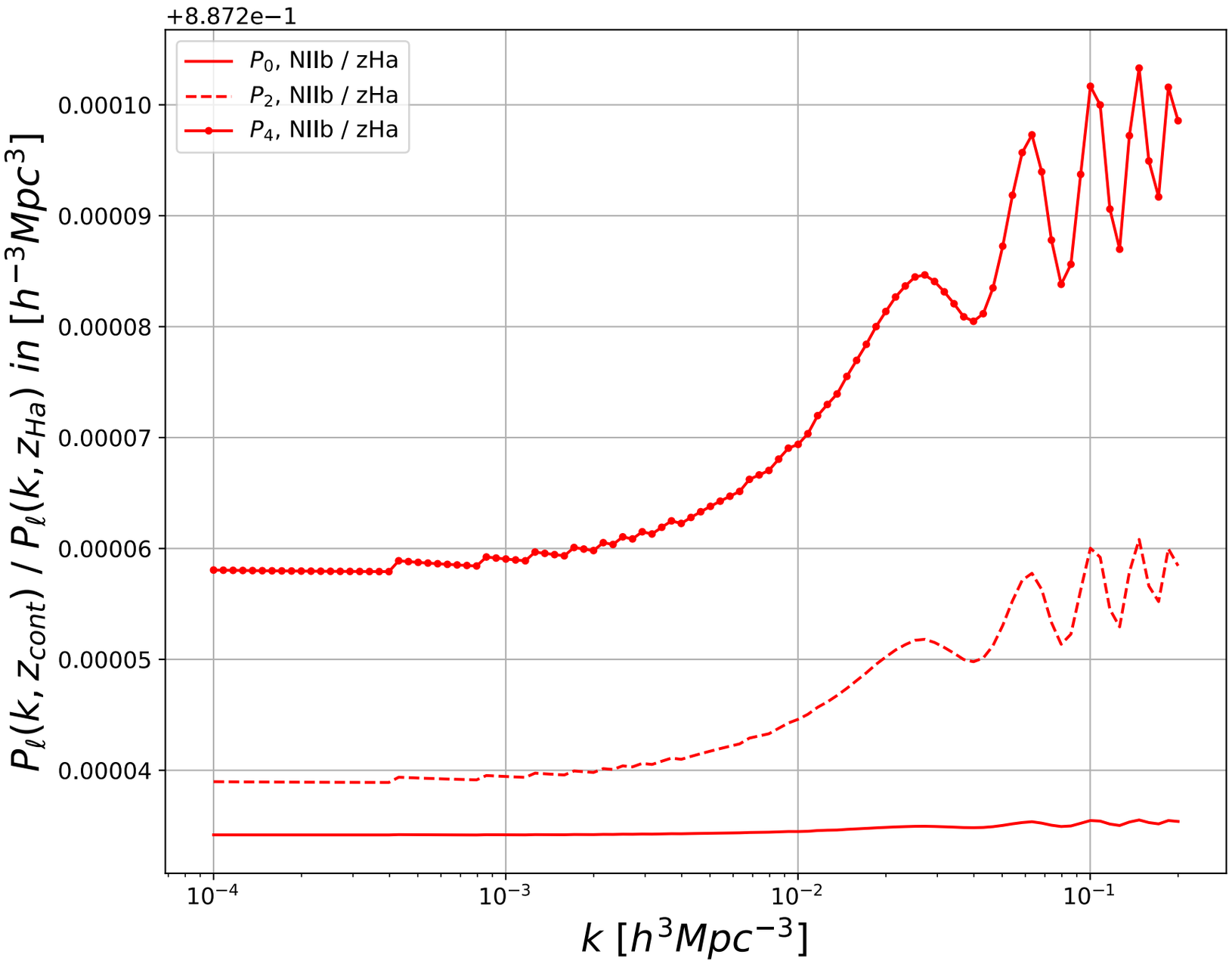
p = **1 (halo mass)**, 1.6 (recent merger)

[A. Slosar et al 2008 Ansatz model]

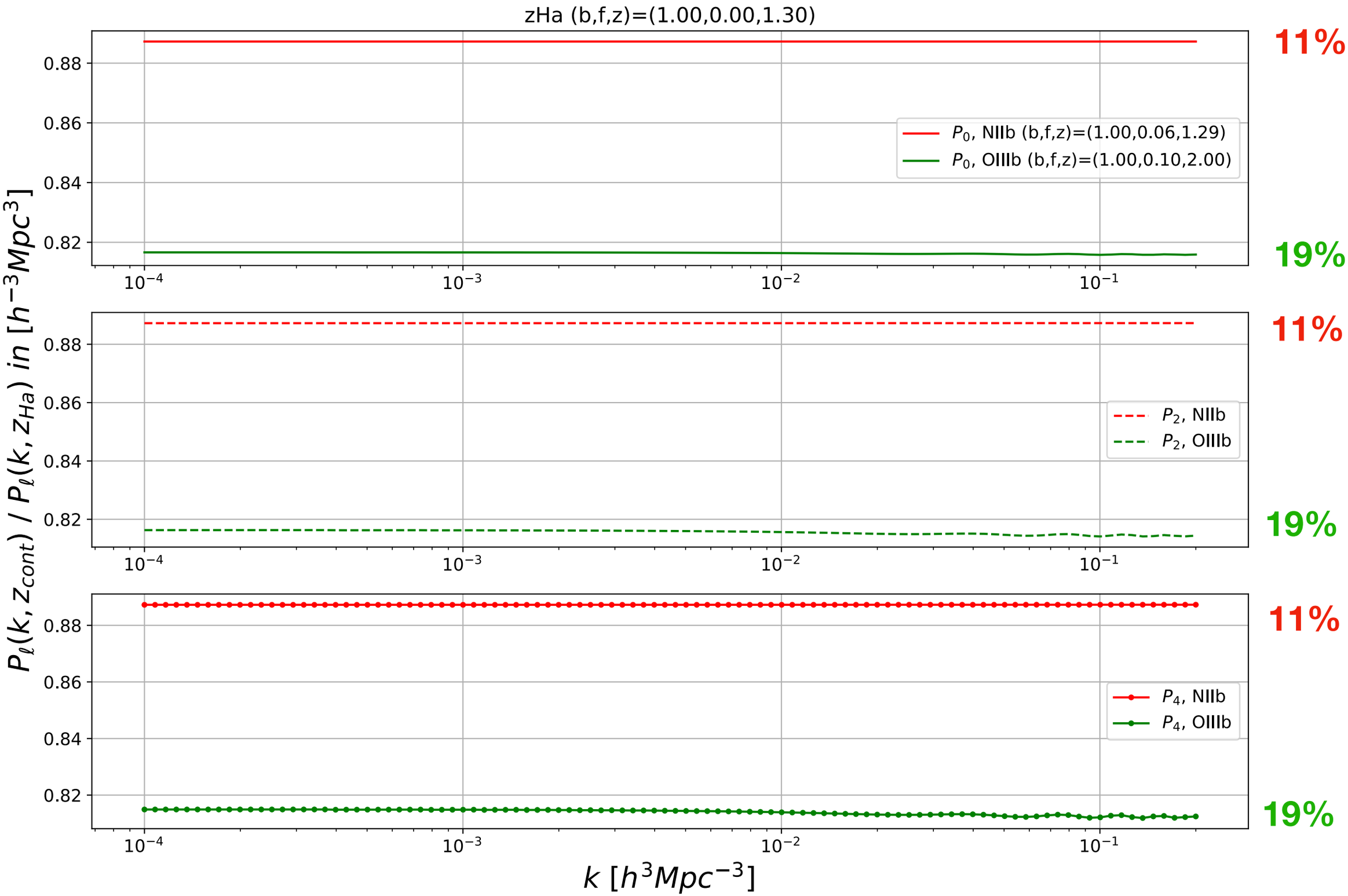
Obs. Syst. of Local Primordial Non-Gaussianity | Obs. Strategy



Obs. Syst. of Local Primordial Non-Gaussianity | Obs. Strategy



f_{NIIb} = 6% **f_{OIIIb} = 10%**



11%

19%

11%

19%

11%

19%

Obs. Syst. of Local Primordial Non-Gaussianity

https://euclid.roe.ac.uk/attachments/download/19263/fnl_euclid_GC_additional_probe.pdf

https://euclid.roe.ac.uk/attachments/download/14648/systematic_errors_may2018.pdf

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