Forecasting LSST Constraints on Primordial Non-Gaussianity

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Objective:

The purpose of this project is to forecast the constraining power of LSST data on physics of inflation in the early universe via measuring the level of primordial non-Gaussianity (pNG) from galaxy clustering and weak gravitational lensing.

Background:

- The simplest model of inflation produces Gaussian initial conditions for the early universe (single field inflation); more complex models predict non-Gaussian initial conditions *(see e.g. Chen 2010).*
- Galaxy bias describes the way in which galaxies populate dark matter halos, and pNG causes scale dependent galaxy biases on large spatial scales and thus changes the relation between galaxies and halos *(Dalal et al., 2007)*.
- Local pNG, parametrized by f_{NL}, can be constrained by analyzing galaxy power spectra on large scales, and its size is a measure for the level of pNG in the early universe.
- So far pNG has not been detected, but galaxy clustering from LSST is expected to yield high signal-to-noise measurements of angular galaxy power spectra at large scales and thus yield competitive constraints on pNG.

Current work:

- Implemented scale-dependent galaxy bias caused by pNG in DESC Bias Challenge.

$$\Delta b(M,k) = 3 f_{\mathrm{NL}}(b-1)\delta_c \frac{\Omega_m}{k^2 T(k) D(z)} \left(\frac{H_0}{c}\right)^2$$

(Slosar et al, 2008)

- To forecast the constraints on f_{NL} obtained from a joint analysis of angular power spectra for LSST Y10 galaxy clustering, galaxy-galaxy lensing and weak lensing, we are using a Fisher matrix approach to compute expected parameter uncertainties

Methodology:

To forecast constraints on f_{NL}, we use a Fisher matrix (FM) approach, which allows us to forecast constraints on model parameters given experimental uncertainties. The FM is the inverse of the covariance matrix and for parameters $\boldsymbol{\theta}_\alpha$, $\boldsymbol{\theta}_\beta$ it is given by

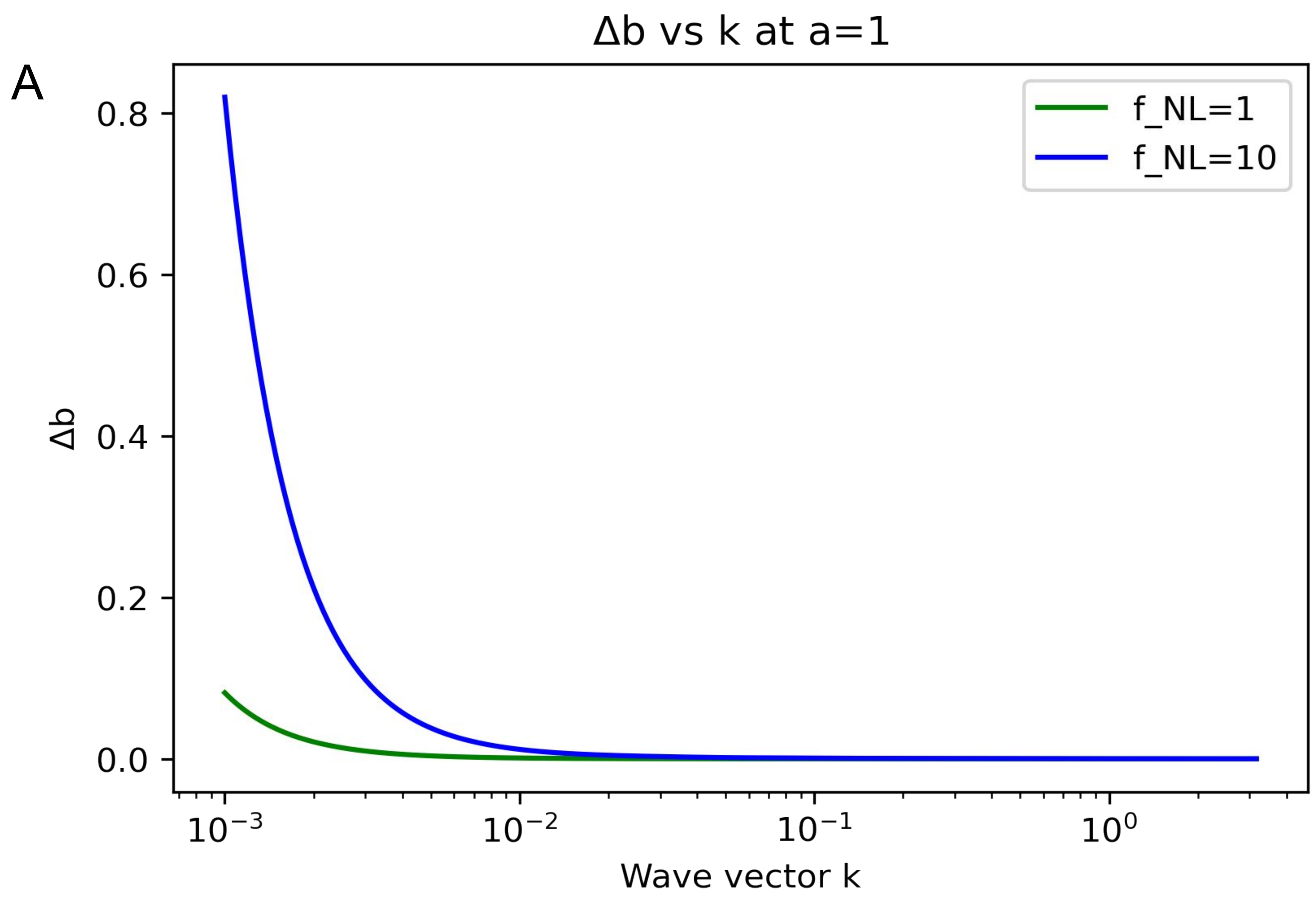
$$\mathrm{F}_{\alpha\beta} \equiv \left\langle \frac{\partial^2 \mathcal{L}}{\partial\theta_\alpha \partial\theta_\beta} \right\rangle$$

(Fisher, 1935)

where L denotes the likelihood of the data.

Future Work:

- Continue to compute forecasts on how well we can constrain f_{NL} using large scale galaxy clustering and weak gravitational lensing data
- Questions we would like to address: how do constraints from galaxy clustering and galaxy-galaxy lensing compare? Can we make use of sample variance cancellation? How do the constraints depend on the wavevector range considered in our analysis?



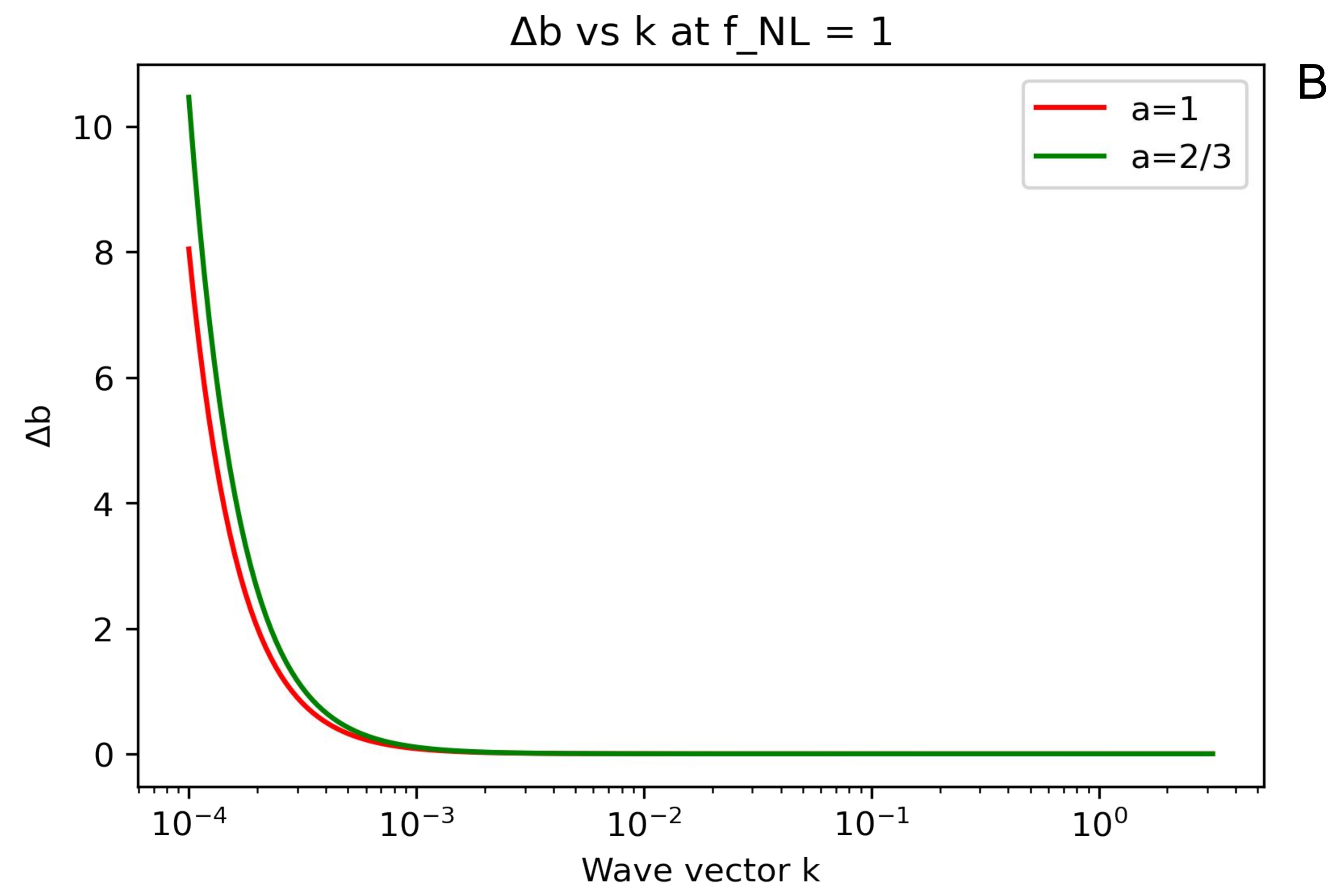


Figure A: pNG bias as a function of wavevector k for two values of a
Figure B: pNG bias as a function of wavevector k for two values of f_{NL}

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