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2006 - 2010 Ph.D. at SISSA

2010 - 2015 Postdoc at NYU

from September Fellow at CERN

Research Interests

- Non-Gaussianity: Consistency relation, new shapes, correlation with scalar-tensor ratio
- String cosmology: Unwinding inflation, ultra-relativistic brane scattering
- Gravity: Cosmology of massive gravity, quasi-dilaton, EFT of dark energy models
- LSS: Fit to N-body simulations
- Other: CMB anomalies, cosmological signals of axions

Non-Gaussianity

EFT for perturbation, general description of single-field models:

$$S_\pi = \int \mathrm{d}^4x \left[\frac{1}{2}M_{\rm Pl}^2 R - M_{\rm Pl}^2 \dot{H}\left(\dot{\pi}^2 - \frac{(\partial_i \pi)^2}{a^2}\right) + 2M_2^4\left(\dot{\pi}^2 + \dot{\pi}^3 - \dot{\pi}\frac{(\partial_i\pi)^2}{a^2}\right) - \frac{4}{3}M_3^4 \dot{\pi}^3 + \ldots\right]$$

$$c_s^{-2} = 1 - \frac{2M_2^4}{M_{\rm Pl}^2 \dot{H}}$$

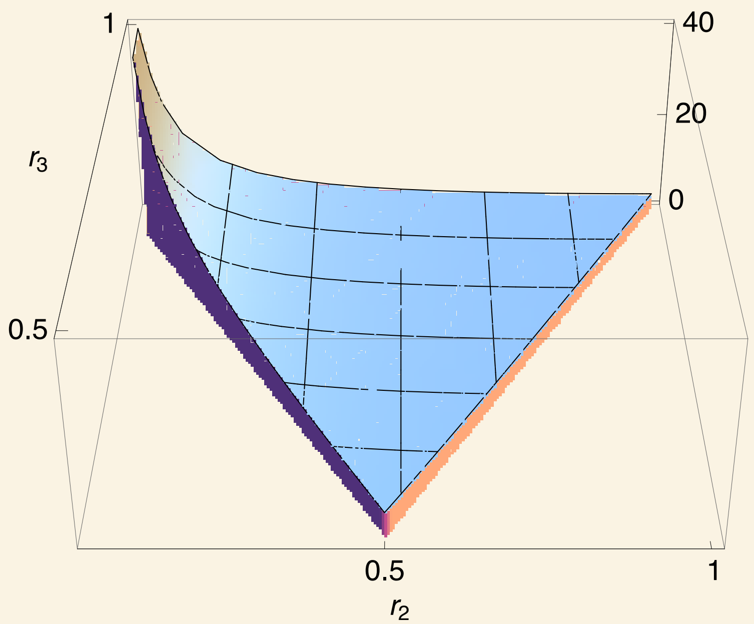
Large NG from small c_s

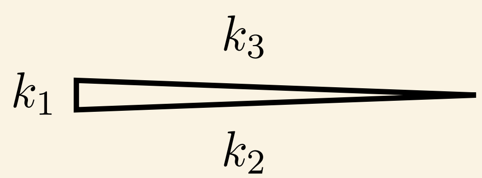
Cheung et al. 2007

Unique probe of interactions during inflation.
Observable: bispectrum

$$\langle \zeta_{\vec{k}_1}\zeta_{\vec{k}_2}\zeta_{\vec{k}_3}\rangle = (2\pi)^3 \delta_D(\vec{k}_1 + \vec{k}_2 + \vec{k}_3) f_{NL} B_\zeta(k_1, k_2, k_3)$$

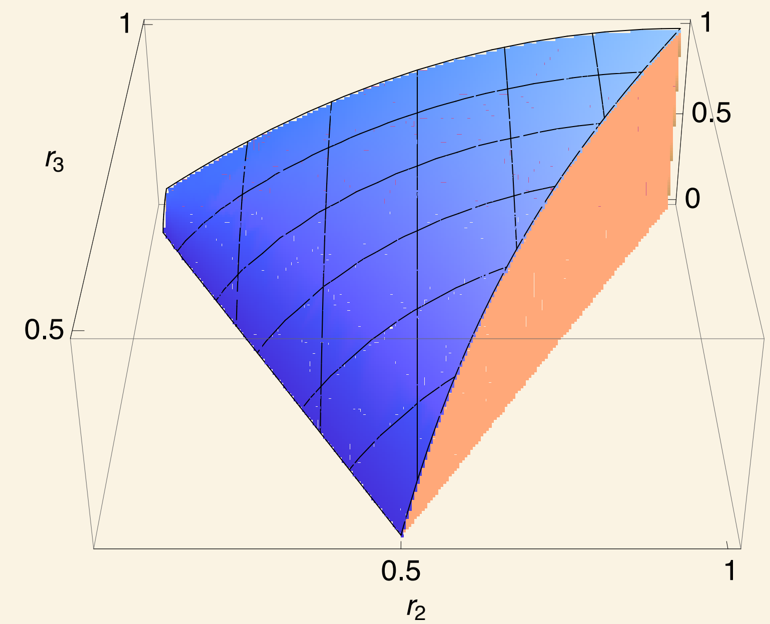
Shapes of non-Gaussianity

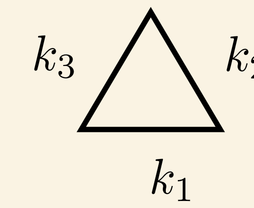




Local

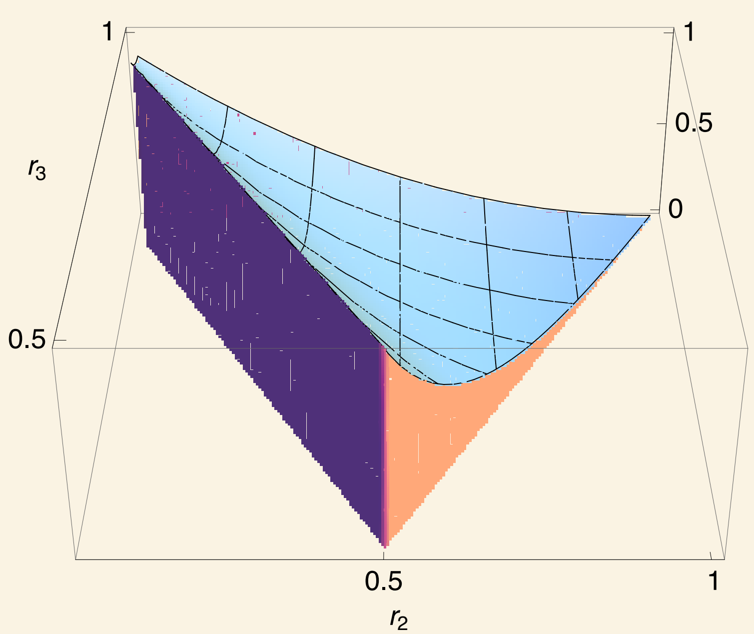
π^3

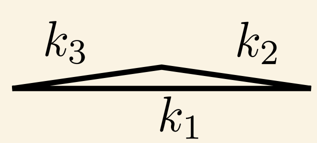




Equilateral

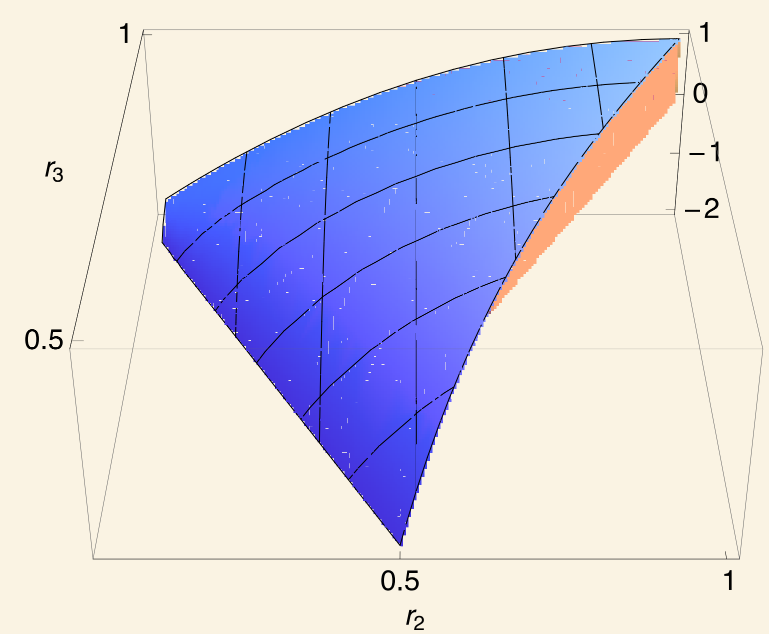
$(\partial\pi)^3$

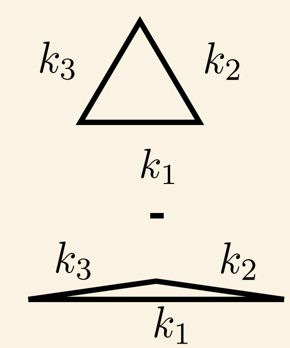




Enfolded

Modified vacuum





Orthogonal

$$\dot{\pi}\frac{(\partial_i\pi)^2}{a^2} + 5.4\frac{2}{3}\dot{\pi}^3$$

A few results

Higher-derivative operators, protected by symmetry -> new shapes of single-field non-Gaussianity

$$S = \int \mathrm{d}^4 x a^3 \Big[-M_{\rm Pl}^2 \dot{H} \left(\dot{\pi}^2 - \frac{(\partial_i \pi)^2}{a^2} \right) + M_1 \ddot{\pi}^3 + M_2 \, \ddot{\pi} \frac{(\partial_i \dot{\pi} - H \partial_i \pi)^2}{a^2} + M_3 \left(\ddot{\pi} \frac{(\partial_i \partial_j \pi)^2}{a^4} - 2H \dot{\pi} \ddot{\pi}^2 + 3H^3 \dot{\pi}^3 \right) \Big]$$

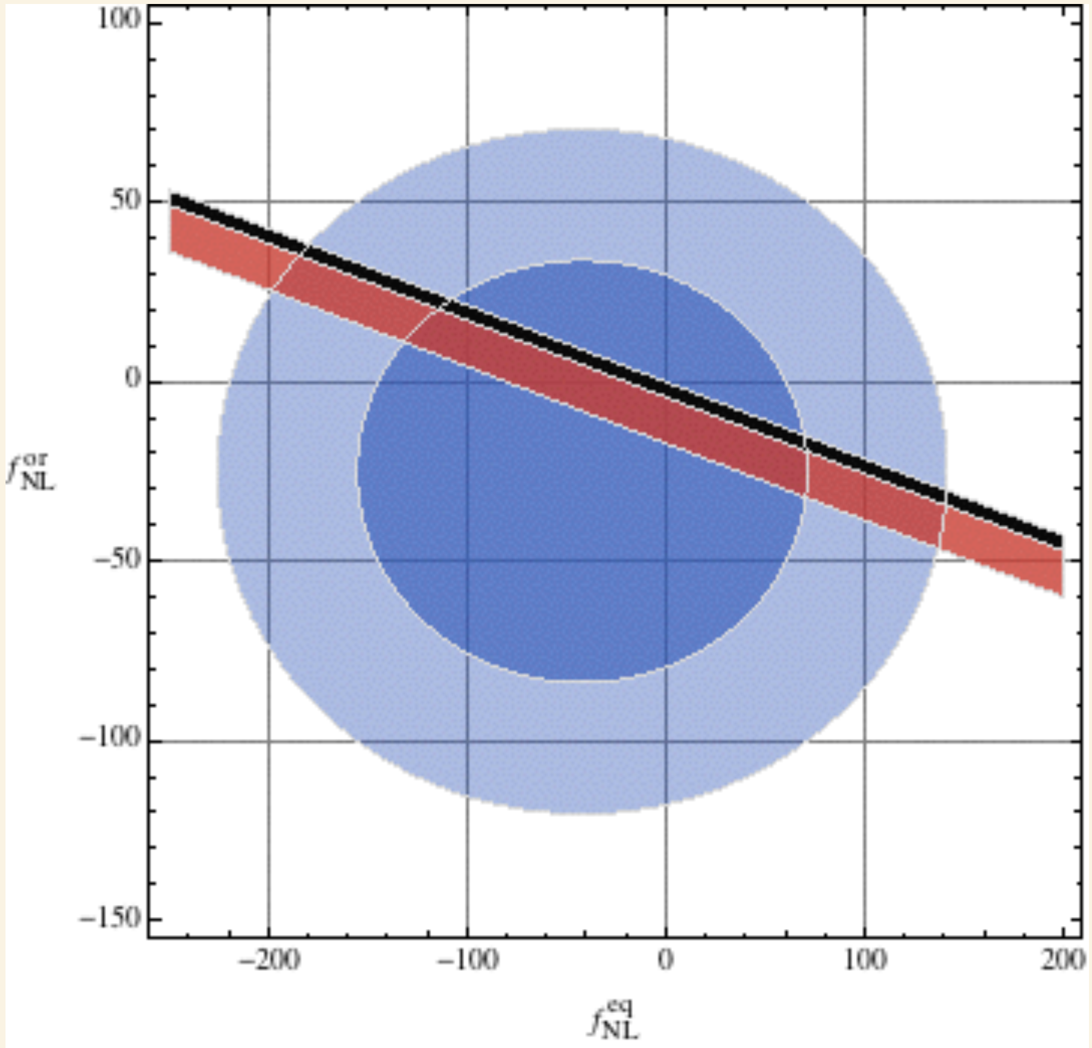
Creminelli, GDA, Musso, Noreña, Trincherini 2011

Consistency relation for the bispectrum:

$$\langle \zeta(\vec{k}_1) \zeta(\vec{k}_2) \zeta(\vec{k}_3) \rangle \simeq -(2\pi)^3 \delta(\vec{k}_1 + \vec{k}_2 + \vec{k}_3) P(k_1) P(k_S) \left[\frac{\mathrm{d} \ln (k_S^3 P(k_S))}{\mathrm{d} \ln k_S} + \mathcal{O}\left(\frac{k_L^2}{k_S^2} \right) \right]$$

Creminelli, GDA, Musso, Noreña 2011

Situation after Planck



GDA, Kleban 2014

Unfortunately, still pretty far from the interesting threshold f_{NL} ~ 1

$$\langle a_{l_1 m_1} a_{l_2 m_2} a_{l_3 m_3} \rangle \simeq \mathcal{T}_{l_1}(k_1)\mathcal{T}_{l_2}(k_2)\mathcal{T}_{l_3}(k_3) f_{NL} B_\zeta(k_1, k_2, k_3)$$

What can we do?

$$\langle \delta_g(\vec{k}_1)\delta_g(\vec{k}_2)\delta_g(\vec{k}_3)\rangle \simeq B_{\delta_g}(k_1,k_2,k_3) + \mathcal{T}(k_1)\mathcal{T}(k_2)\mathcal{T}(k_3) f_{NL} B_\zeta(k_1,k_2,k_3)$$

LSS bispectrum in the future, many more modes but hard to disentangle non-linearities!

Perturbation theory useful up to a point, tests on non-Gaussian simulations

First trial on SDSS data