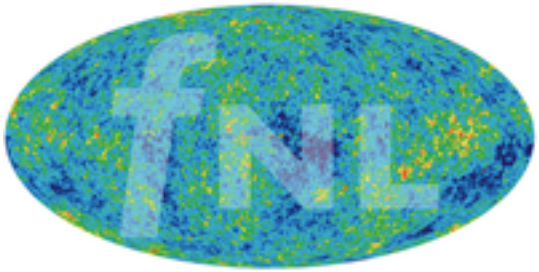
Concluding remarks



Critical Tests of Inflation Using Non-Gaussianity

Sabino Matarrese
Physics & Astronomy Dept. "Galileo Galilei"
University of Padova, Italy
INFN, Padova, Italy

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NG from single-field inflation

- Inflation is by far our best "*non-abracadabra*" model for initial conditions (M. Zaldarriaga)
- EFT of inflation is a very useful tool to explore model phenomenology / there are still some unexplored corners (e.g. small 3 and large 4-point function)
- Maldacena's consistency relations a potential discriminant "can be proven wrong – viceversa much harder!" / Conformal CR (P. Creminelli)
- Quasi-single field (QSF) inflation models: shapes of bispectrum (in the squeezed limit) directly measure the mass (X. Chen)
- degeneracy: detection of a local component can mean either multi-field or QSF inflation
- Consistency relation vs theoretical limitations:
    - i) no sub-horizon correlations (e.g. non-BD, features)
    - ii) no super-horizon evolution (non-attractor)
- Non BD initial states (S. Shandera, R. Flauger) → e.g. consequences on halo bias; effects from heavy fields on bispectrum & trispectrum (M. Jackson)

NG from multi-field inflation

- Curvaton "paradigm": allows to get large local f_{NL}, scale-dependent, ... (D. Wands)
- detection of $f_{NL}^{local} \sim O(10)$ would not only rule out all single-field models, but would also rule out a large class of multi-field models (J. Meyers)
- Single field → Adiabaticity: data so far are consistent with purely adiabatic perturbations (no evidence for non-adiabatic ...)
- account for potential correlations between adiabatic & isocurvature perturbation modes, also for NG (D. Langlois)
- generalized δN formalism to account for isocurvature modes → generalized bispectra (generalization of local NG)
- Technicalities about predictions / validity of δN formalism (D. Seery)
- Non-negligible reheating effects on f_{NL} in multi-field inflation (C. Byrnes)
- NG from vector fields (less studied than scalars, but ...) (M. Peloso)
- $f(\varphi)F^2$ → most likely outcome: too much anisotropy!
- Role of non-scalar modes and anisotropy issues (M. Shiraishi)
- Relevance of SY inequality / calculation of τ_{NL}/f_{NL}^2 relation in modulated reheating scenario (M. Yamaguchi)

Discussion

What are the most promising ways to produce f_{NL} ~ O(10)?

- curvaton
- modulated reheating
- modulated trapping
- preheating
- multibrid
- ...

How to pin down inflation candidates?

- $f_{NL} - g_{NL}$ useful
- Suyama-Yamaguchi inequality
- scale-dependence of f_{NL}
- Isocurvature modes
- ...

After knowledge of f_{NL} what next should there be?

- angular dependence
- scale-dependence,
- g_{NL}
- ...

NG from LSS: theory

- In many cases non-linearities play a crucial role: *at least* N-body simulations are needed (L. Verde)
  - how well do we know the gravitational instability bispectrum?
  - how well do we know bias?
  - how does bias interfere with NG and viceversa?
  - how do we combine power-spectrum and bispectrum measurements?
  - Relativistic corrections: how important are they, how well modeled?
  - effects from merging
- Galaxy (halo) bispectrum potentially very powerful in constraining PNG, but many complications arise (non-linearities, biases, ...) → heroic effort by D. Jeong, E. Sefusatti, ...!
- Clustering of peaks (V. Desjacques) → mass function and bias
- Impact of PNG on halo mass function. Press-Schechter inspired formulae (M. LoVerde) see also M. Musso poster
- Comparison with observations: lots of challenges for NG w. clusters, but data exist/will arrive (and these challenges aren't different from constraining DE w. clusters!)

NG from LSS: observational hints

- Clustering of LRG in SDSS III (photometric spectra available for ~ 10%) / QSOs (S. Ho)
- Is there statistical evidence for $f_{NL}^{local} \neq 0$?
- Conservative analyses consistent w. $f_{NL}^{local} = 0$ (T. Giannantonio)
- Beware of bias redshift evolution! (e.g. bias = const ≠ 1 unphysical)

data	f_{NL} ± 1 sigma	
WMAP7	32 ± 21	
SDSS QSO	40 ± 15	sample 1
SDSS QSO	30 ± 15.5	sample 2
CCF	4 ± ~ 10	...
Planck	?? ± ~ 5	early 2013

CMB and its contaminants

- Bispectrum (non)-separability issues and mode decomposition(s) (K. Smith, J. Fergusson)
- Reinterpretation in terms of Information Field Theory (T. Ensslin)
- How to deal with ISW-lensing bispectrum “contaminant” (J. Kim)
- Knowledge of second-order effects crucial (N. Bartolo, F. Vernizzi)
- The 2^{nd}-order radiation transfer function in the squeezed limit → bias on f_{NL} local much smaller than Planck forecasted accuracy
- Bias on f_{NL} equilateral much smaller than Planck forecasted accuracy
- Still a lot of work to be done! (C. Fidler) see also poster by G. Pettinari
- The higher sensitivity of Planck requires better control of systematics (B. Wandelt, M. Liguori) see also poster by A. Renzi
- Foregrounds provide in principle more significant challenge for f_{NL} measurements than WMAP
- Needlets as a useful diagnostic of foreground contamination

Discussion

– EK: “don’t talk about” ... real-world issues (e.g. non-linearities, baryons, ...)

the ultimate goal: reconstruction of the initial seed field(s)

CMB	Halos/galaxies	Gravitational lensing	Reionization / 21 cm
bispectrum	bispectrum/ trispectrum	bispectrum	
trispectrum	rare events: P(k) of halos	abundance of halos	
topology	rare events: halo abundance / voids		
	topology		
	halo profiles		

Conclusions

Thanks to **Eiichiro** & Xingang, Shirley, Marco, Sarah, Masahide for organizing this wonderful workshop!

Thanks to MPA for hospitality (special thanks to Maria Depner)

X. Chen: *"we don't know which cards Nature is prepating for us"*

S. Matarrese: *"you don't know which cards Nature is prepating for us"*

... until Planck data release!