Exploring the effects of primordial non-Gaussianity at galactic scales

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PNG on small scales: current status

propage PNG $\rightarrow$ test inflationary physics

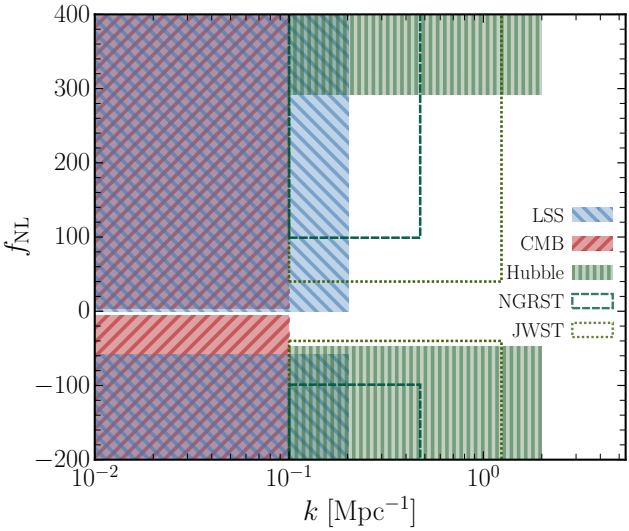
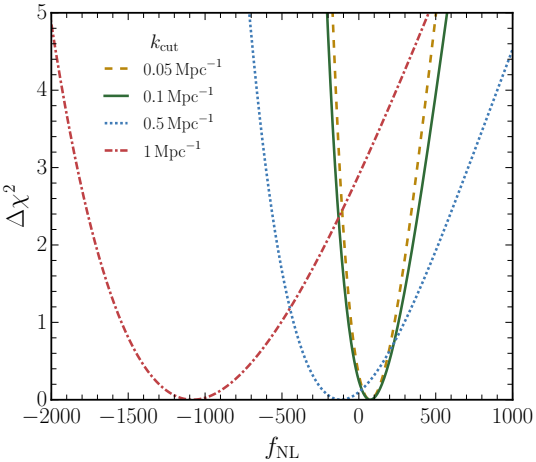


Image credit: Sabti 2009.01245

PNG on small scales



Sabti 2009.01245

- Study UV galaxy luminosity function of Hubble telescope
- A detection at 1.7 σ.
  Most likely a bump in the data, but who knows... $\rightarrow$ JWST, NGRST
- Using another model of dust extinction, no more detection

Scale dependant PNG

Several models of strongly scale dependant PNG

Beyond slow roll

- Khoury 0811.3633: time-dependant sound speed
- Riotto 1009.3020: scalar field with abrupt change of mass
- Byrnes 1108.2708: curvaton-self interactions

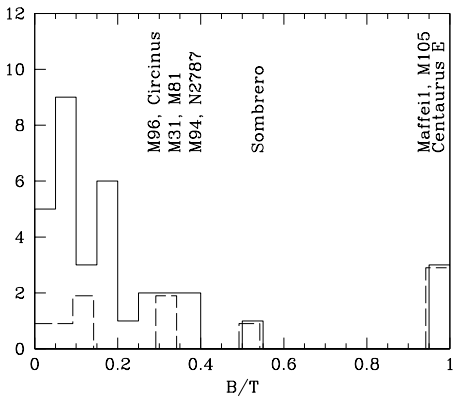
- Can parametrize with $n_{f_{NL}} \equiv \frac{d \ln f_{NL}}{d \ln k}$
- Planck 1905.05697: constraints on running NG $\rightarrow$ compatible with 0.

Large PNG on scales smaller than $k_{CMB/LSS} \equiv k_{\text{cut}} = \mathcal{O}(0.1)$ Mpc^{-1}

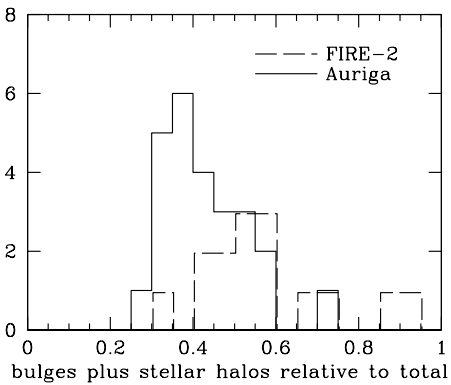
$$B_\Phi = f_{NL} P_\Phi(k_1) P_\Phi(k_2) \Theta(k_i - k_{\text{cut}}) + 5 \text{ perm.} \quad (1)$$

Peebles 2005.07588: study bulge to total luminosity of galaxies

Observations

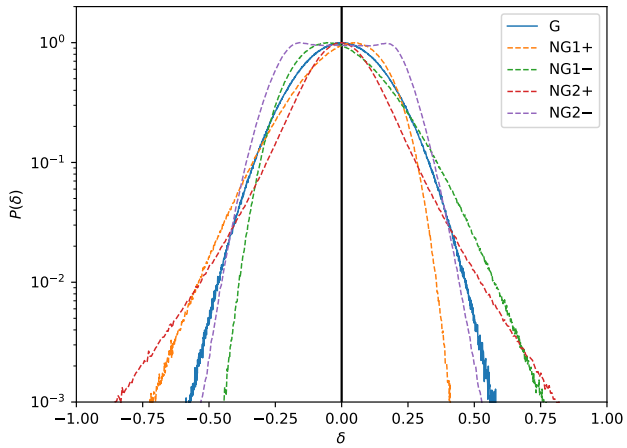


Simulations



- "Hot orbit problem" naturally solved if galaxies have a calmer environment, and form through a calmer history.
- Baryon feedback play a crucial role here
- Initial condition modification has also been tested: *genetic modification* (Stopyra 2006.01841), splicing (Cadiou 2107.03407), modify initial angular momentum (Cadiou 2206.11913).

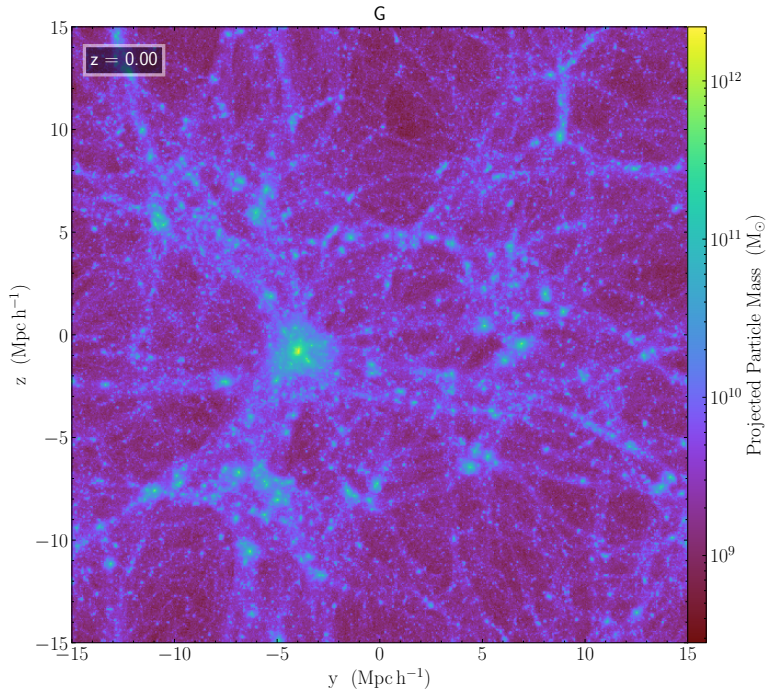
Numerical setup



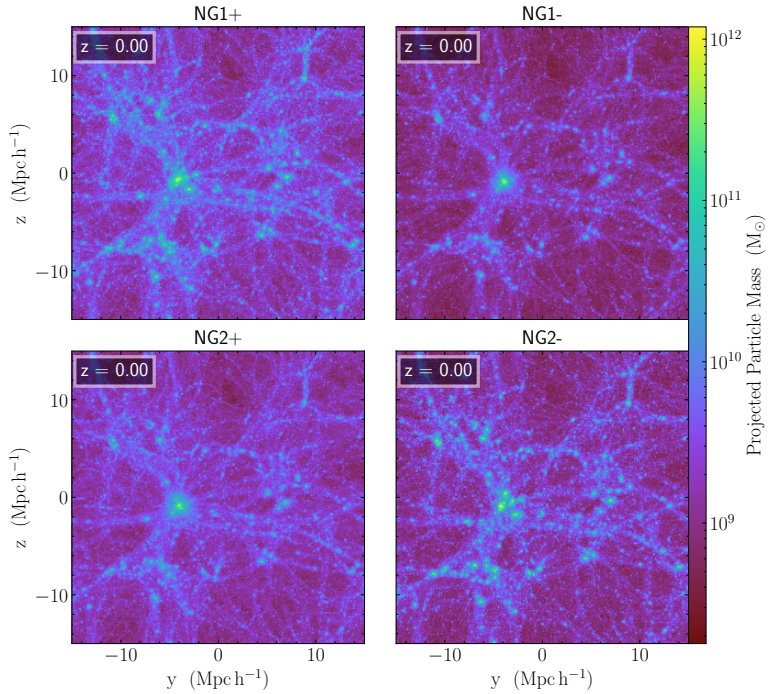
- Toy models: NG of $\pm\mathcal{O}(1000)$ for f_{NL} or g_{NL} at $\mathcal{O}(20)$ Mpc.
- Dark Matter Only simulations[a]
- Grid : 512^3, BoxSize : 30 Mpc/h, Effective resolution 100 kpc/h.
- Total mass in the box: $2.3 \times 10^{15} M_\odot$, mass of DM particle $1.7 \times 10^7 M_\odot$

[a] Work with `Gadget4` (`https://wwwmpa.mpa-garching.mpg.de/gadget4/`) and `Monofonic` (`https://bitbucket.org/ohahn/monofonic/src`).

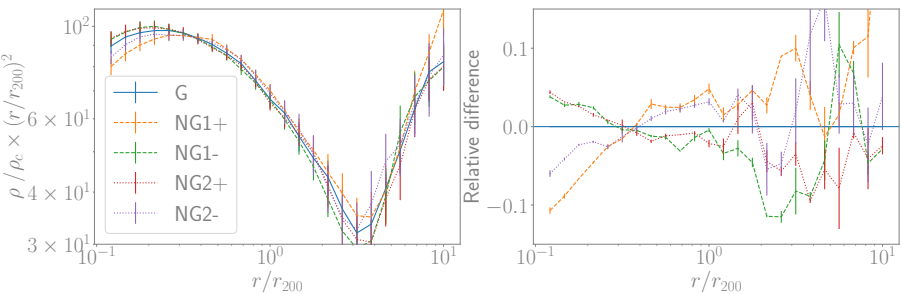
Halos in quieter environments



Halos in quieter environments

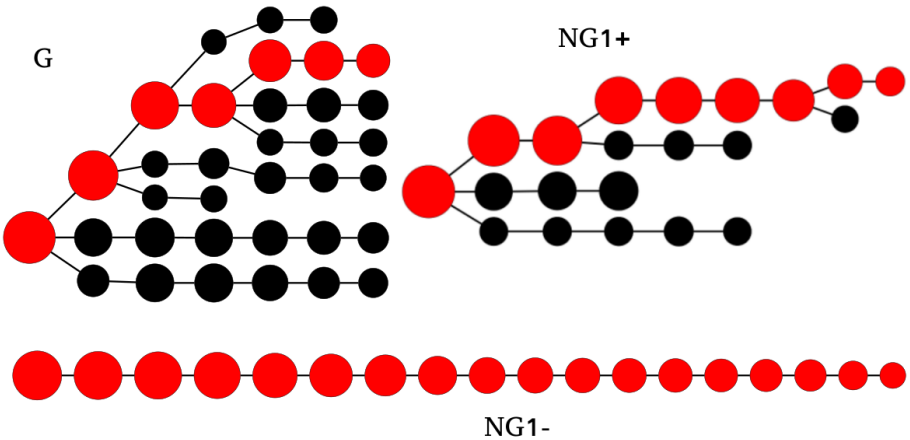


Density profiles



- Stacked result on our sample of the 100 more massive halo found in each simulation. $M_h \in \left[1.6 \times 10^{14}; 1.1 \times 10^{12}\right] M_\odot$.
- Similar study to Smith 1009.5085, though our box is much smaller.

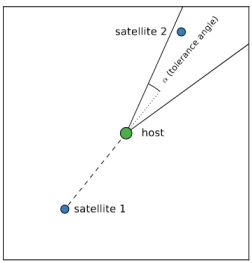
Merging history

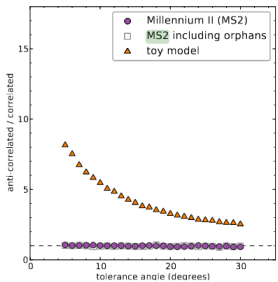


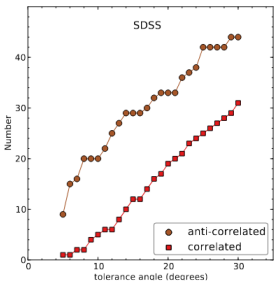
Simulation	G	NG1+	NG1-	NG2+	NG2-
z_{50}	0.64	0.59	0.67	0.64	0.62
mF [%]	78	52	71	61	108

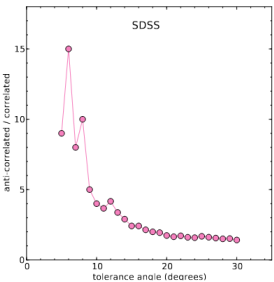
Correlated subhalos?

A classical test of the litterature (Ibata 1407.8178): dwarf satellite galaxies are aligned in thin and kinematically coherent planar structures



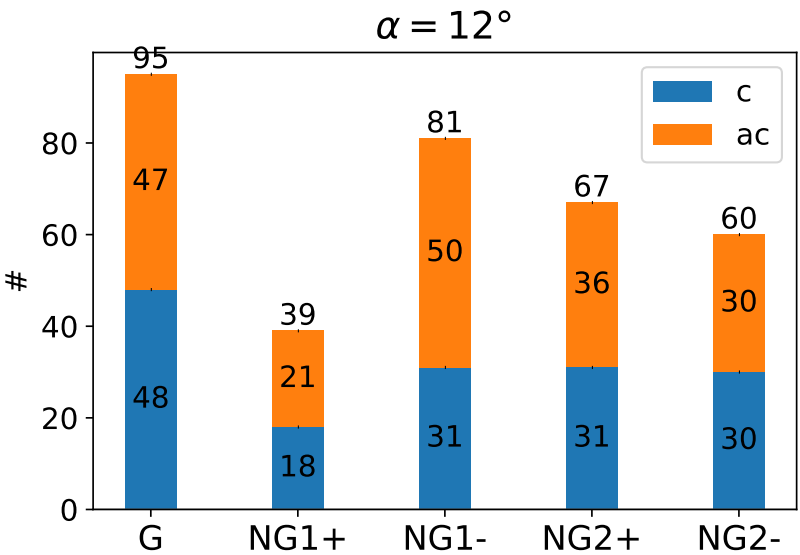






Correlated subhalos?

Simulation	G	NG1+	NG1-	NG2+	NG2-
ac/c, 12 degrees	1.1	1.2	1.7	1.4	1.1

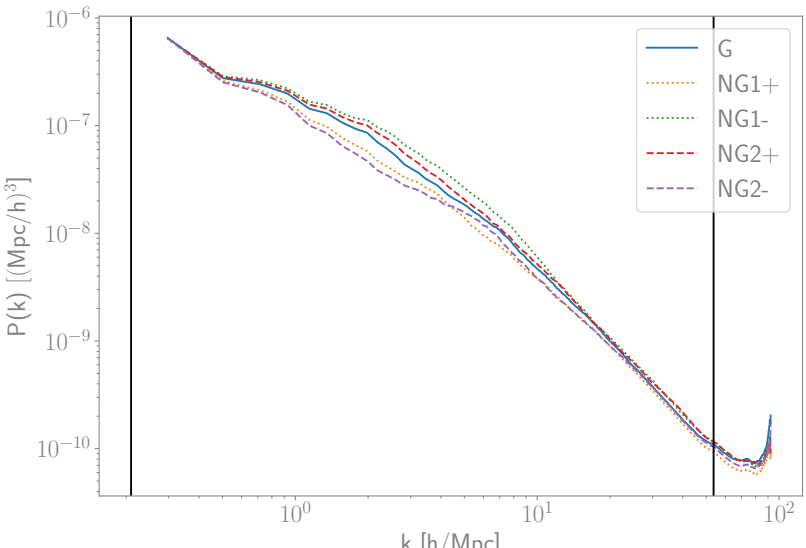


Conclusions

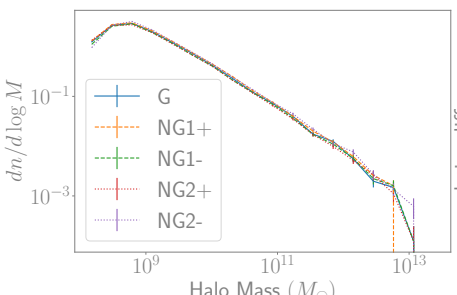
- Explored the effect of large PNG on small scales.
- Possible to have a quieter merging history leading to more planar and coherent structures (model NG1-)
- I will revisit several small scales (galactic) problems with NG1-
- Need to back up these explorations with more simulations: zoom on one galaxy in a cosmological background.
- Easy to extend to WDM or Effective Theory of DM (ETHOS, α, β, γ parametrization)

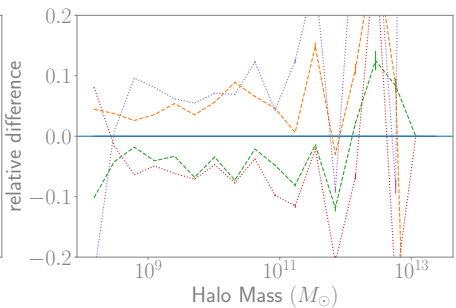
Thank you for your attention

Power spectra



Halo Mass Function





Some technical details

- Work with `Gadget4` () and `Monofonic` ().
- Measure power spectra with `Pylians` ()
- Detect halos with SUBFIND ()
- Construct merger trees with `ytree`

`Monofonic` is nice

Handling of the numerical errors due to aliasing: multiplication in Fourier space leads to noise close to the Box Size. Neat implementation of Orszag's 3/2 rule () allow to dealiase any field.

Get the correct σ_8

The toy model of Eq. 1 for $f_{\mathrm{NL}} \gg 1$ leads to a wrong measure of σ_8. We corrected for that by changing the overall amplitude of our primoridal fluctuations.

Correlated subhalos?

Simulation	G	NG1+	NG1-	NG2+	NG2-
ac/c, $\alpha = 12$ deg	1.1	1.2	1.7	1.4	1.1
ac/c, $\alpha = 25$ deg	0.95	1.2	1.6	1.2	1.1