PNG in the non-linear matter/halo density fields

PNG: Primordial non-Gaussianity

- **Tiny deviations from Gaussianity of primordial fluctuations**
- **Shape** (e.g. local, equilateral, orthogonal) and **amplitude** $f_{\rm NL}$ depending on the model of inflation
- Current best constraints from **CMB measurements** (Planck)
- In the future: **LSS surveys**, requires to model accurately gravitational non-linearities

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Simulation-based approach with Quijote-PNG

*W. Coulton, **GJ**, F. Villaescusa-Navarro, D. Karagiannis, D. Jamieson, M. Liguori, M. Baldi, L. Verde, B. Wandelt*

4000 N-body simulations with PNG

- 3 PNG shapes: local, equilateral and orthogonal
- Volume: $1\ (\mathrm{Gpc}/h)^3$
- 512^3 dark matter particles
- Run with GADGET-III

⇒ Information content of the non-linear matter and halo density fields studied in:

2206.01624, **2206.01619**, **2206.15450**, **2211.07565**

All simulations are publicly available!

https://quijote-simulations.readthedocs.io/en/latest/png.html

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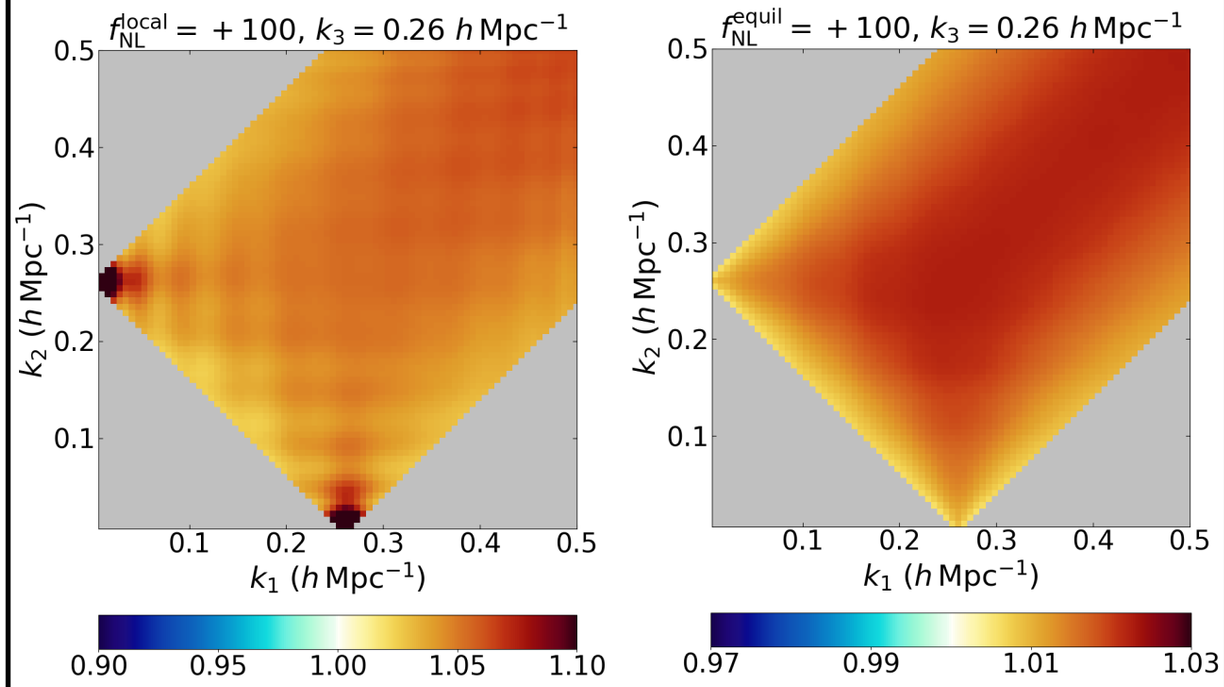
Bispectrum

3-point correlation function in Fourier space

$$\langle \delta(\boldsymbol{k}_1)\delta(\boldsymbol{k}_2)\delta(\boldsymbol{k}_3)\rangle = (2\pi)^3\delta_D(\boldsymbol{k}_1+\boldsymbol{k}_2+\boldsymbol{k}_3)B_\delta(k_1,k_2,k_3)$$

Standard summary statistic to study PNG



Bispectrum: (simulations with PNG) / (no PNG)

Gabriel Jung (IAS Orsay)

PNG in the non-linear matter/halo density fields

Joint Fisher analyses of ΛCDM cosmological parameters and PNG amplitudes $f_{\rm NL}$

Using ~25000 simulations (Quijote + Quijote-PNG) at $z = 1$, up to $k_{\rm max} = 0.5\,h/{\rm Mpc}$, volume: $1\ ({\rm Gpc}/h)^3$

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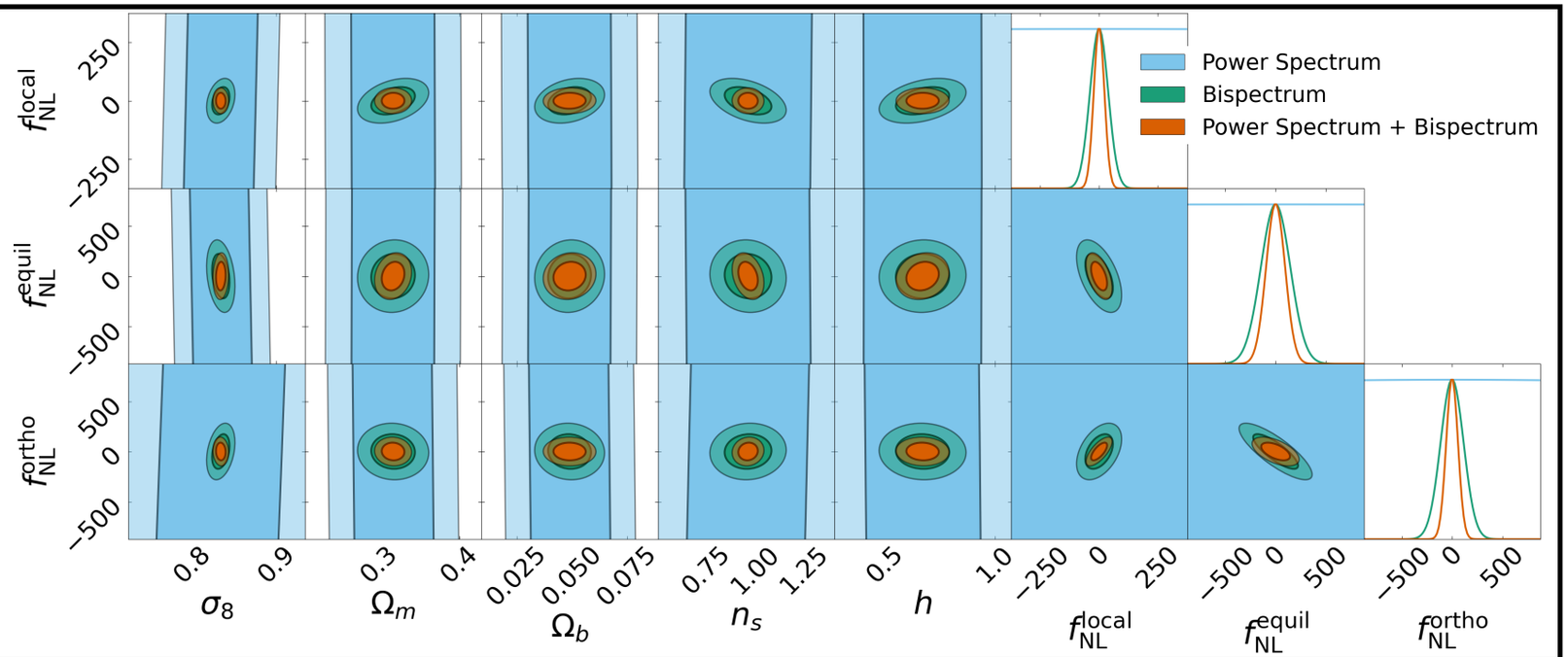
Dark Matter field

Fisher constraints from the **power spectrum** and **bispectrum**, up to **non-linear scales** $k_{\rm max} = 0.5\,h/{\rm Mpc}$

⇒ Bispectrum results on PNG are improved significantly by including the power spectrum in the analysis!



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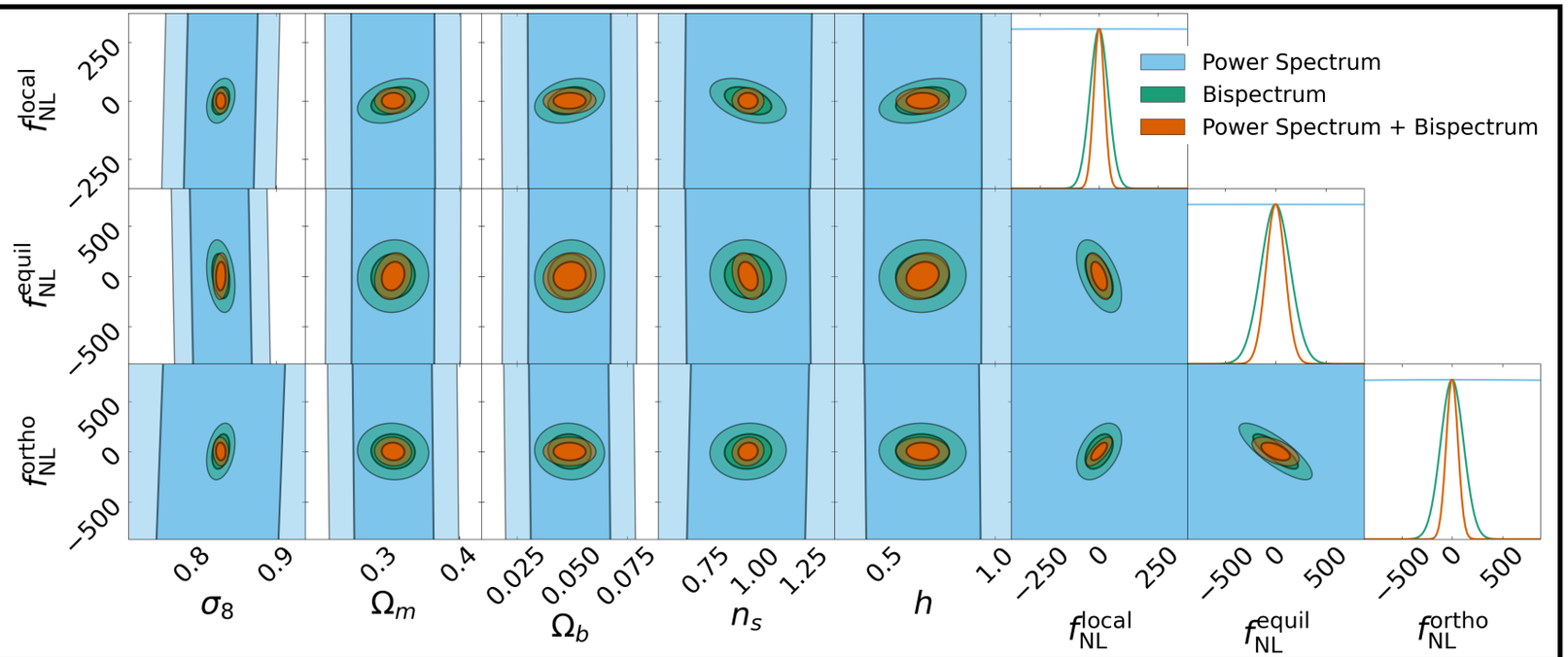

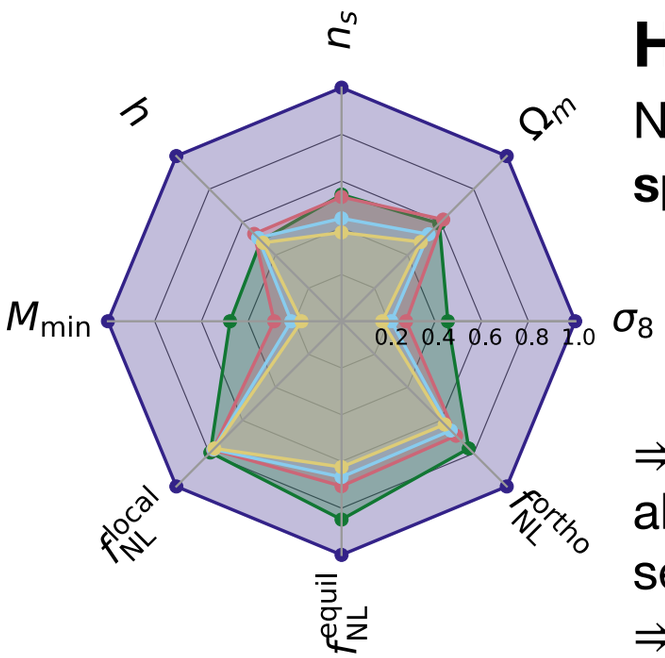

Halo field (Masses $> 3.2 \times 10^{13}\,M_\odot/h$)

Normalised 1-σ Fisher error bars from **power spectrum + bispectrum**

- $k_{\rm max} = 0.1\ h\,{\rm Mpc}^{-1}$
- $k_{\rm max} = 0.2\ h\,{\rm Mpc}^{-1}$
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⇒ Should be included in future PNG analyses

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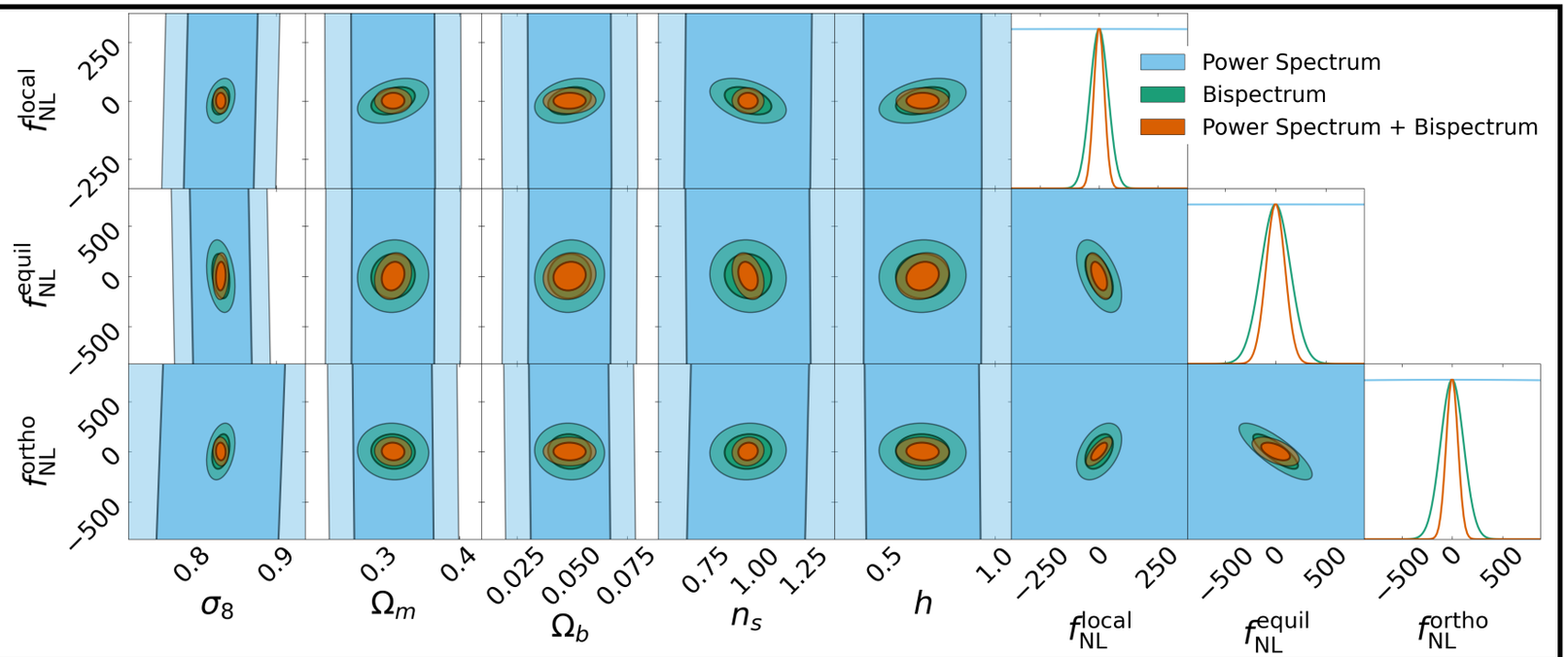

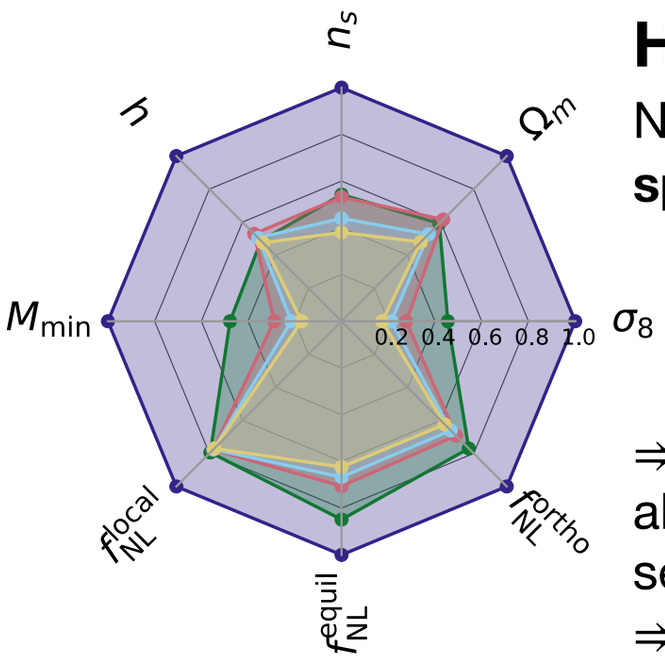

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Conclusion

We also have an estimator!

More in:

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- 2206.01619
- 2206.15450
- 2211.07565

Thanks!

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