Radio as a Unique Probe To Access the Largest Cosmic Scales

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Primordial Non-Gaussianity

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- Predicted in many scenarios of inflation
- Tightest available constraints from CMB: $|f_{\rm NL}| < 10$ [Planck Collaboration, 2015]

Primordial Non-Gaussianity

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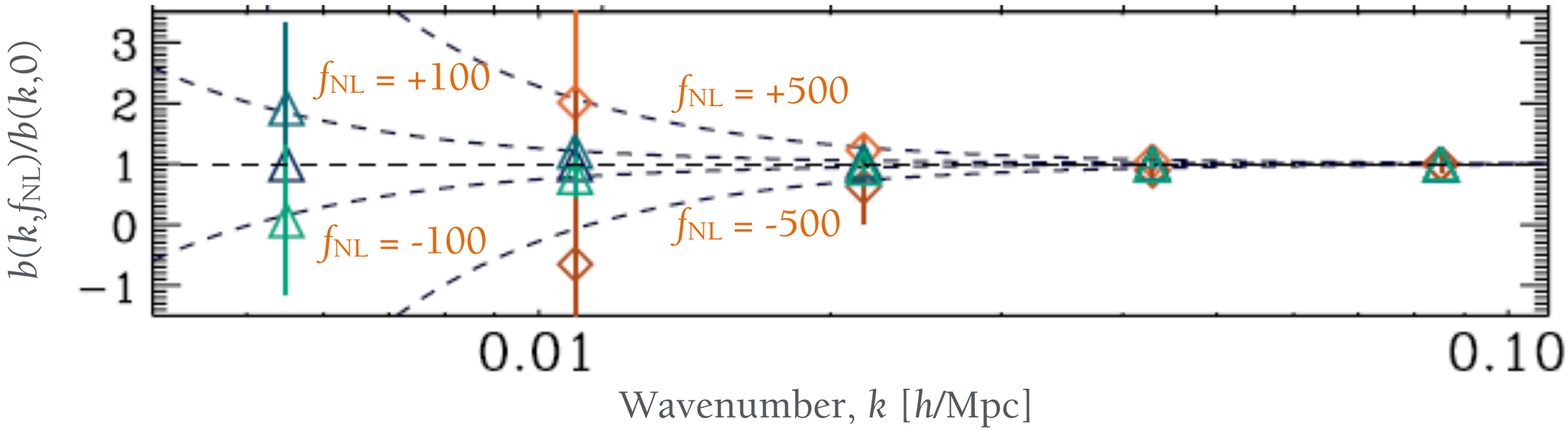
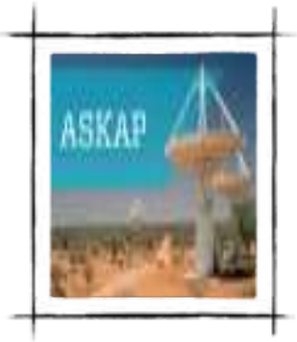
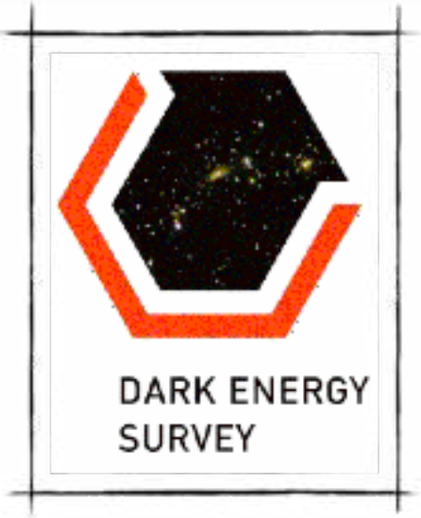
- Accuracy of $O(1)$ possible w/ future large-scale galaxy surveys

[Dalal et al., 2008]



Accessing the Largest Scales





Accessing the Largest Scales

- Forecasts on primordial non-Gaussianity for galaxy surveys

  - $\sigma(f_{\rm NL}) \sim 1.5$
    [SC, Santos & Maartens, 2015]

  - $\sigma(f_{\rm NL}) \sim 2 - 4$
    [Carbone, Matarrese & Verde, 2008; Giannantonio *et al.*, 2012]

Accessing the Largest Scales

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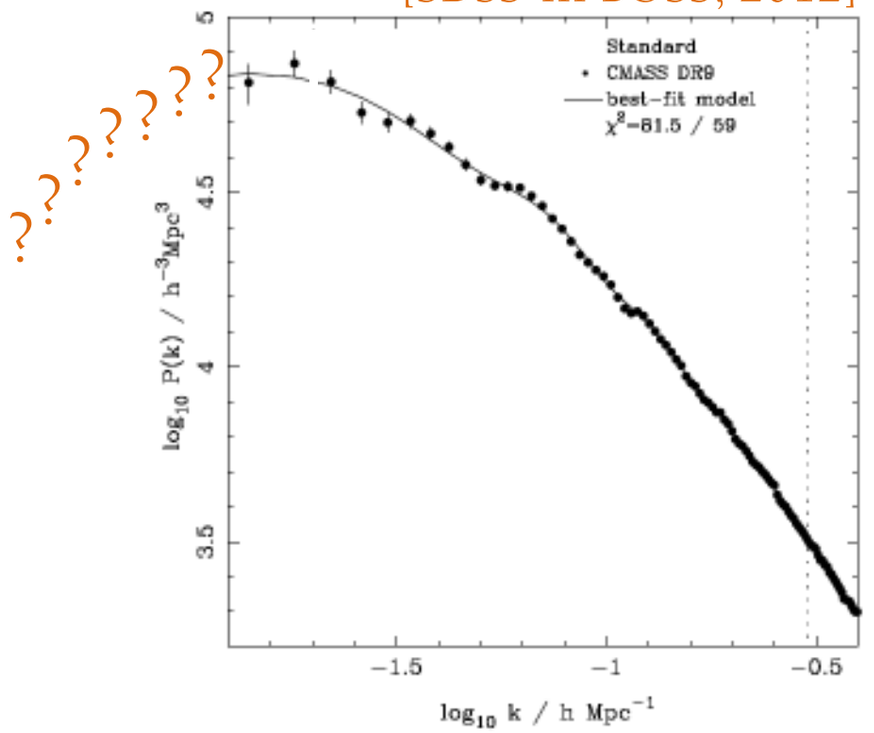
[SDSS-III BOSS, 2012]



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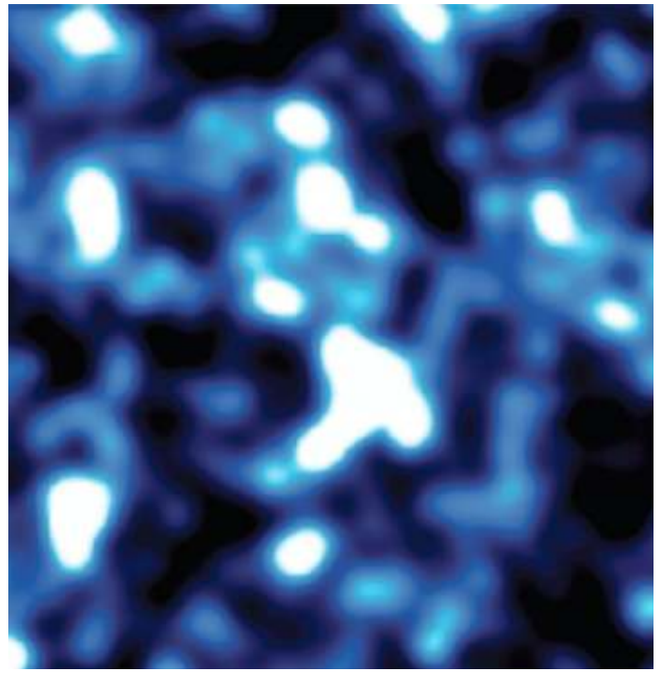
Intensity Mapping



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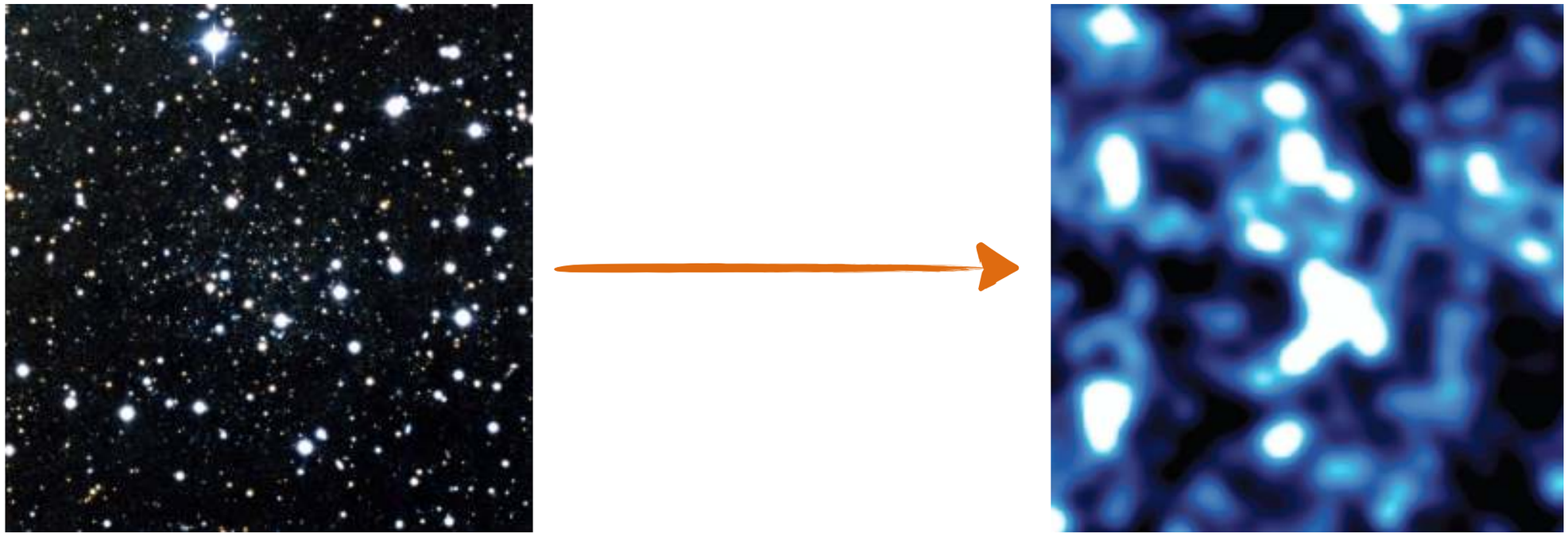

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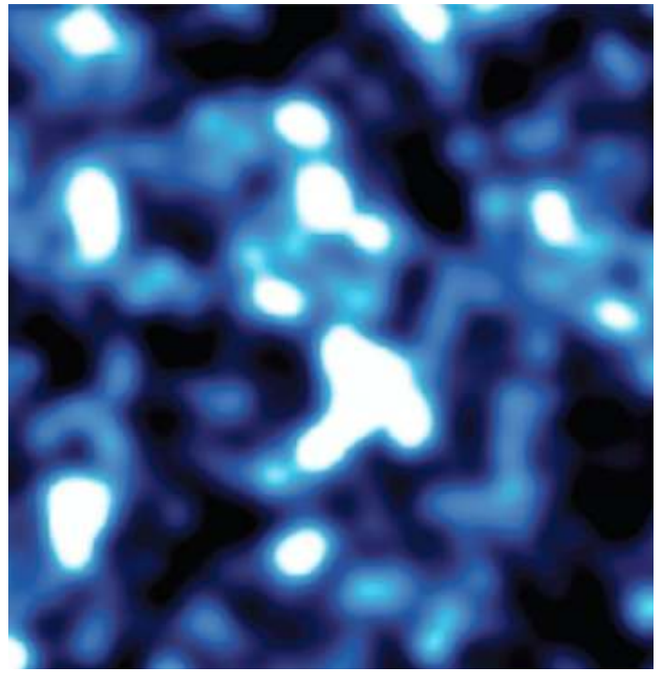

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- Developed for radio dish surveys / interferometers: SKA $\sigma(f_{\rm NL}) \sim 1$

[SC, Santos, Ferreira & Ferramacho, PRL 2013]

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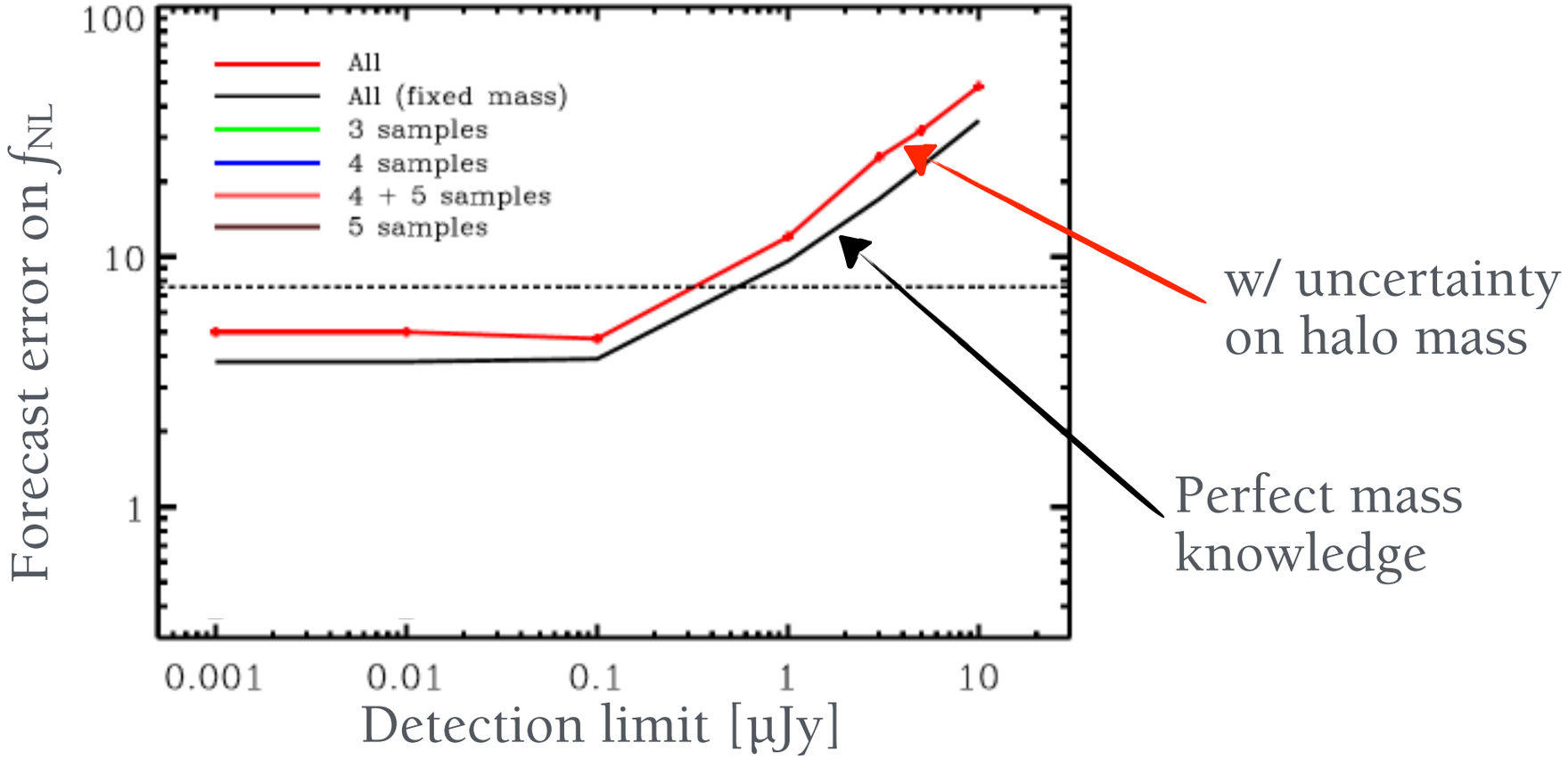

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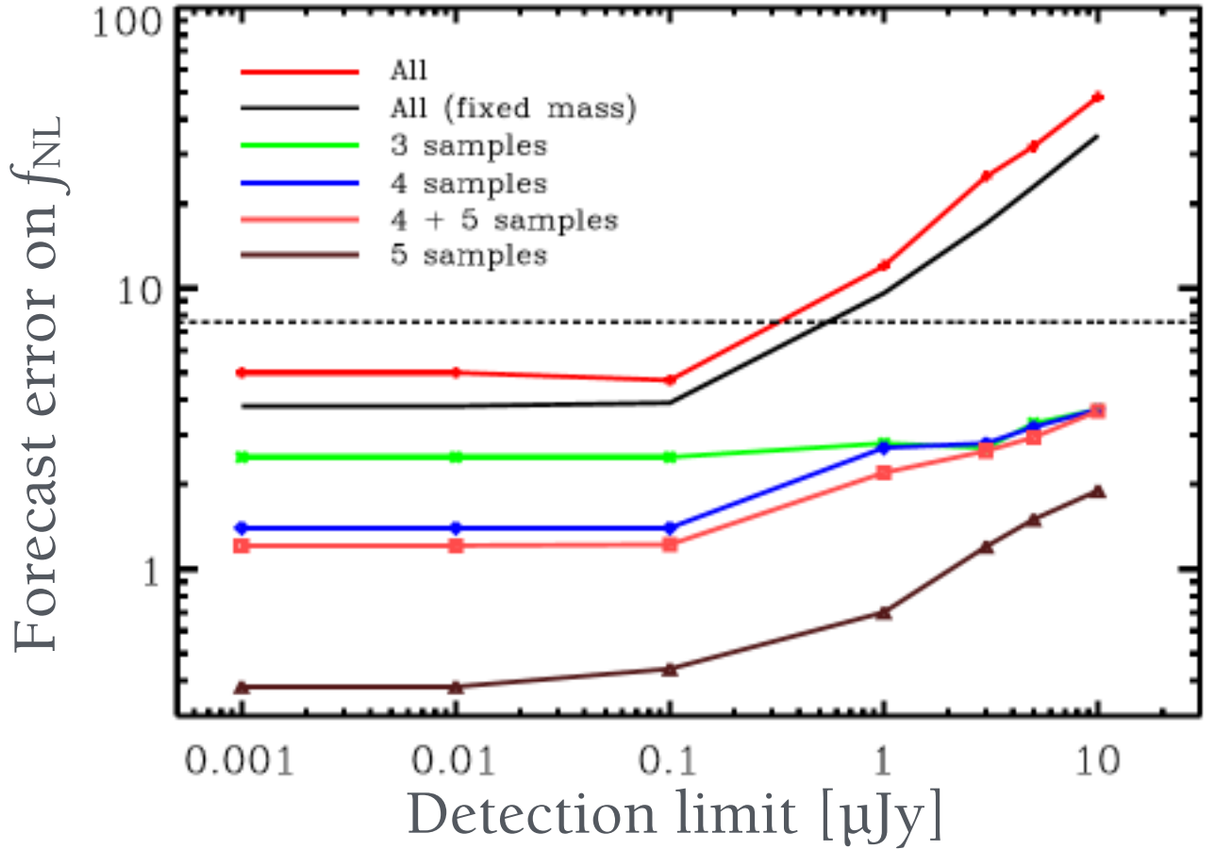

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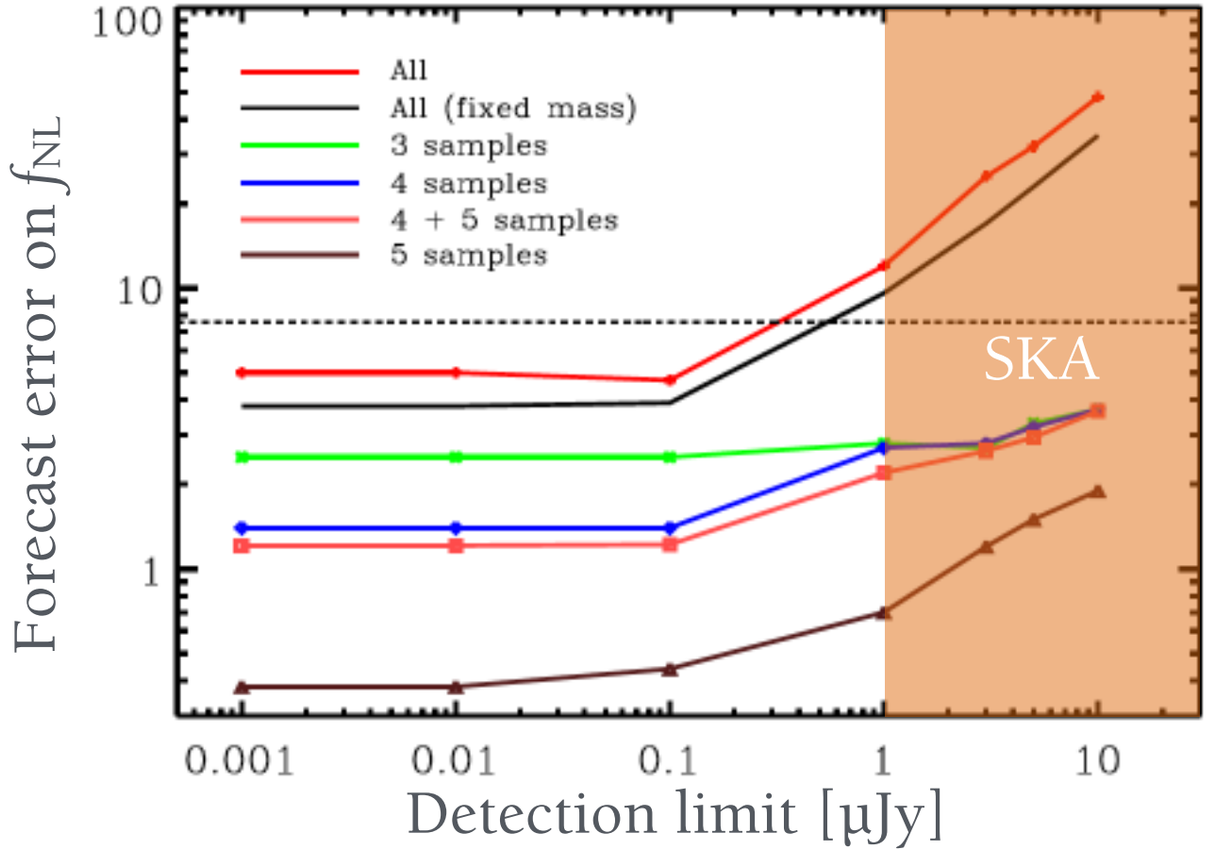


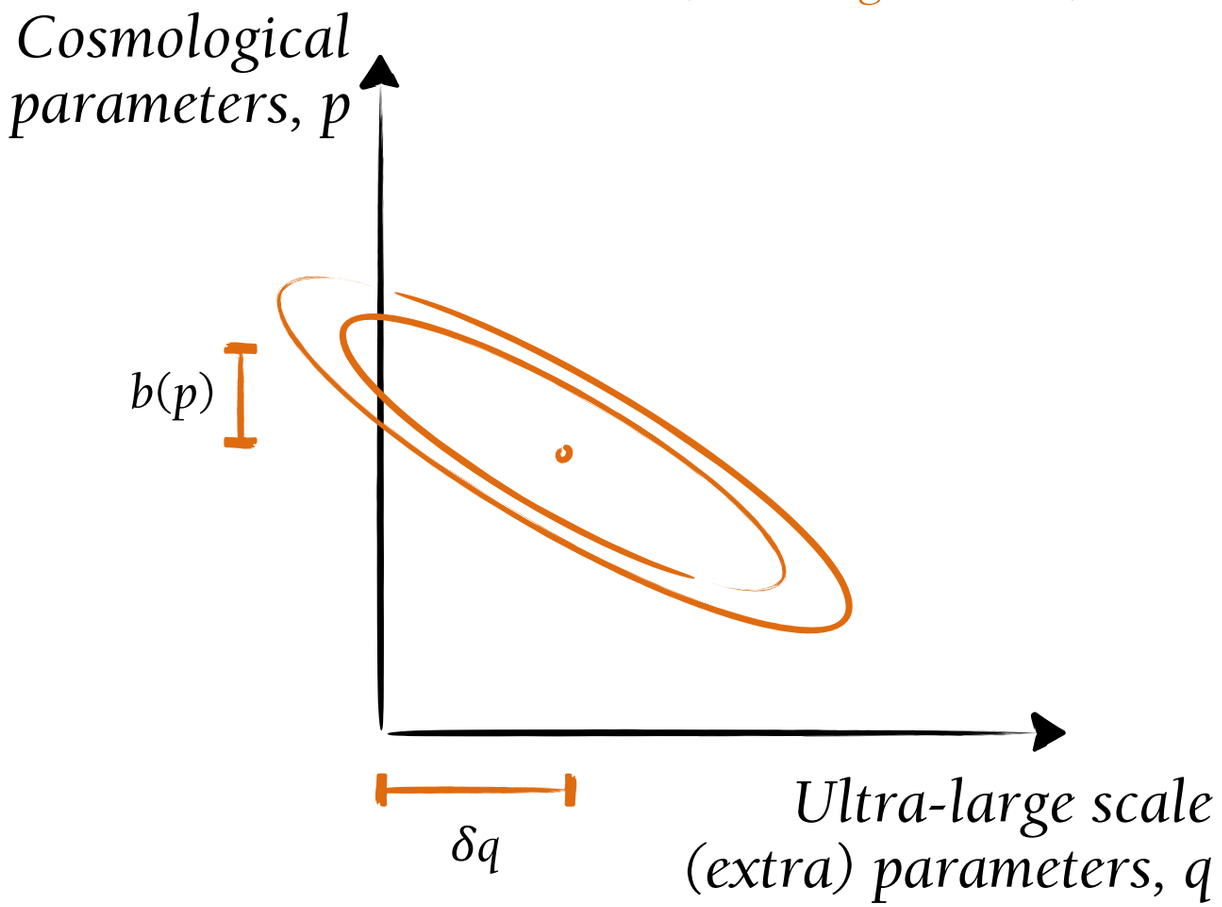
Summary

- Constraints on the properties of density perturbations on extremely large scales will improve our understanding of the law of gravity
  - The largest scales are a playground for possibly unknown physics *(modified gravity?)*
  - They can further confirm Einstein's general relativity *(tests for relativistic corrections)*
- They can also improve our knowledge of inflation and early Universe *(e.g. primordial non-Gaussianity)*
- Radio has a unique potential in accessing the largest cosmic scales! *(HI intensity mapping, multi-tracer technique…)*

Ultra-Large Scales Matter!

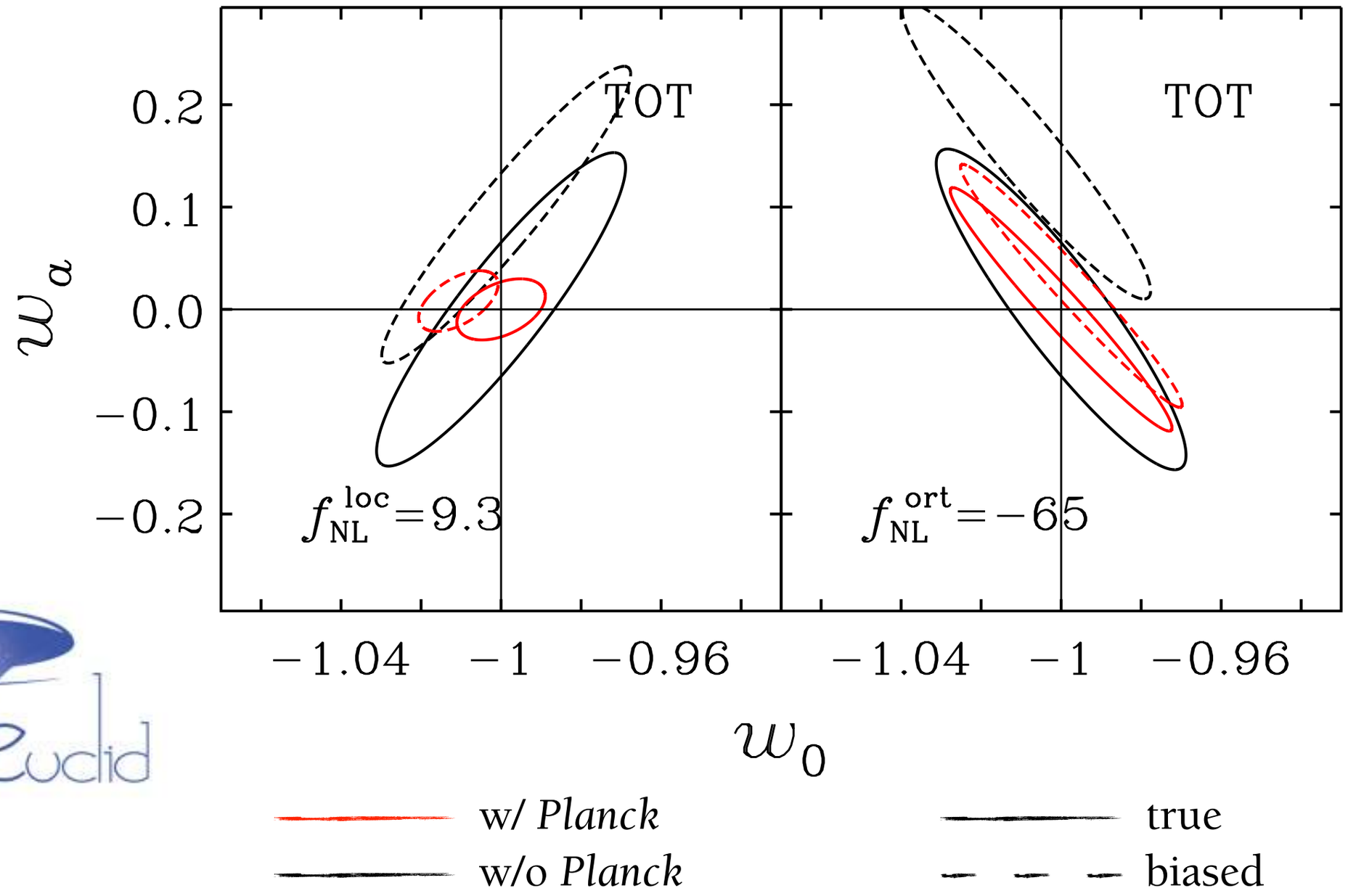
- Neglecting ultra-large scale effects can undermine future cosmological experiments' accuracy

[Heavens, Kitching & Verde, 2007]



Neglecting non-Gaussianity

[SC, Carbone, Fedeli & Moscardini, 2015]



Neglecting Relativistic Effects

[SC, Maartens & Santos, 2015]