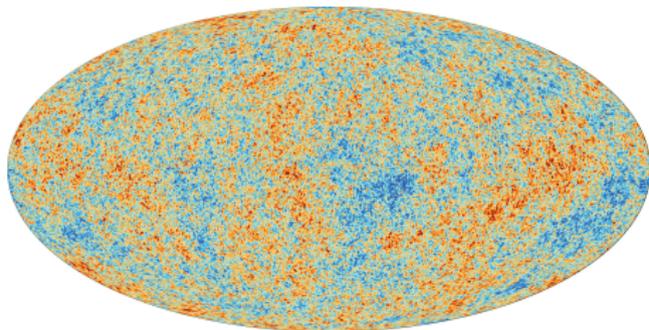


Kinetic Field Theory applied to Cosmic Structure Formation

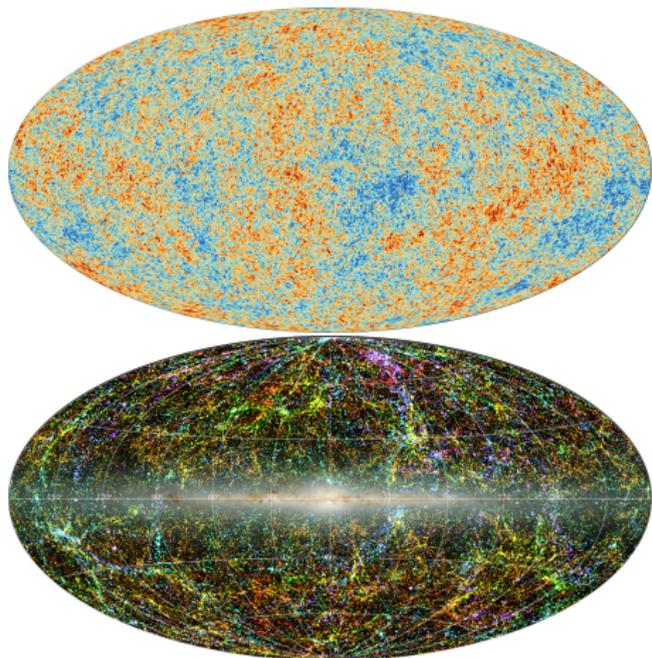
Matthias Bartelmann

Institute for Theoretical Physics, Heidelberg University

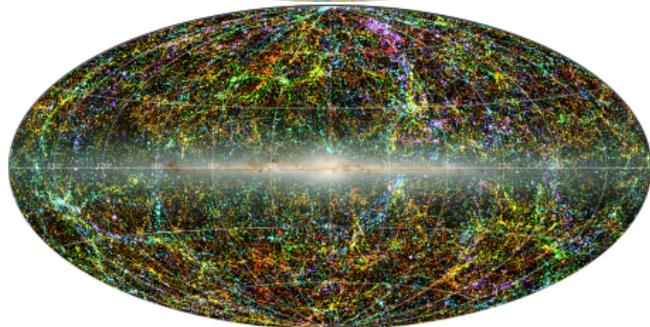
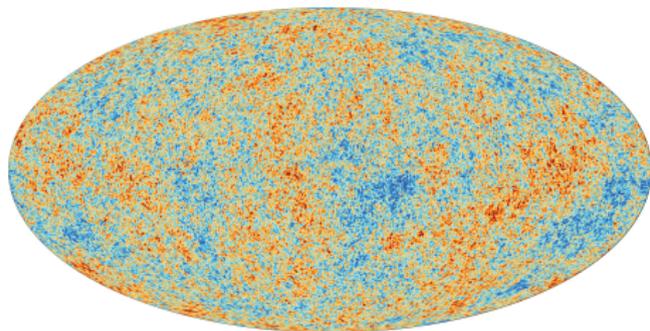
Motivation



Motivation



top: Planck 2018; bottom: 2-MASS



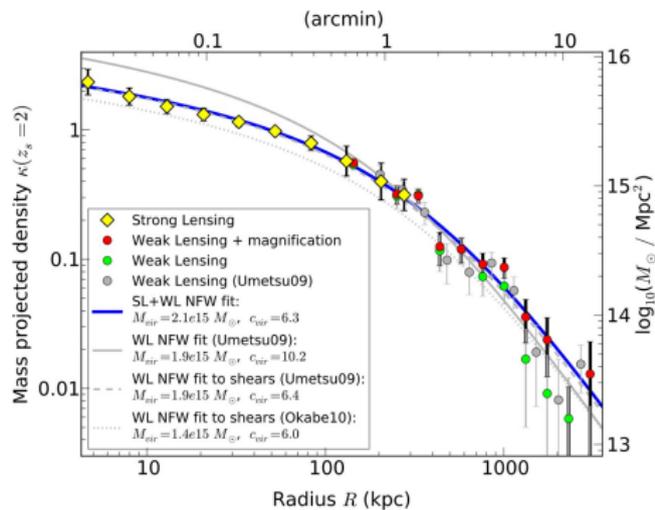
top: Planck 2018; bottom: 2-MASS



Abell 2261



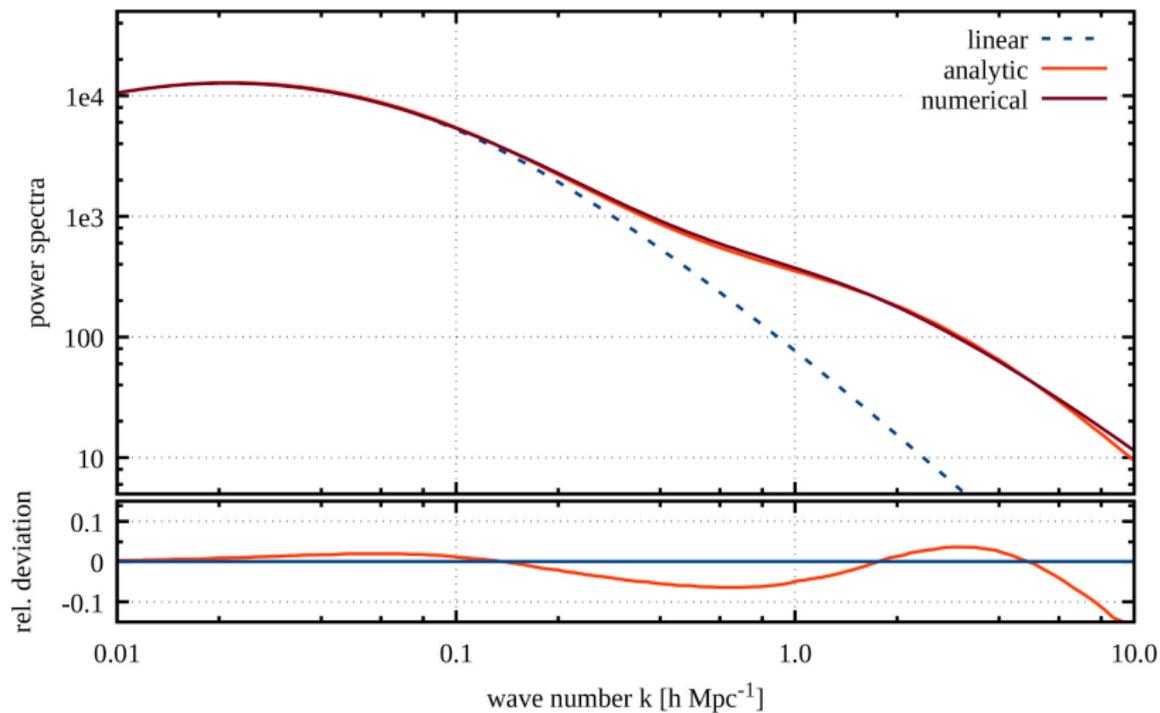
Abell 2261



Coe et al. 2012

$$P_{\delta}^{(\text{nl})}(k) = e^{\langle S_1 \rangle} \mathcal{P}(k)$$

Mean-field result for non-linear power spectrum

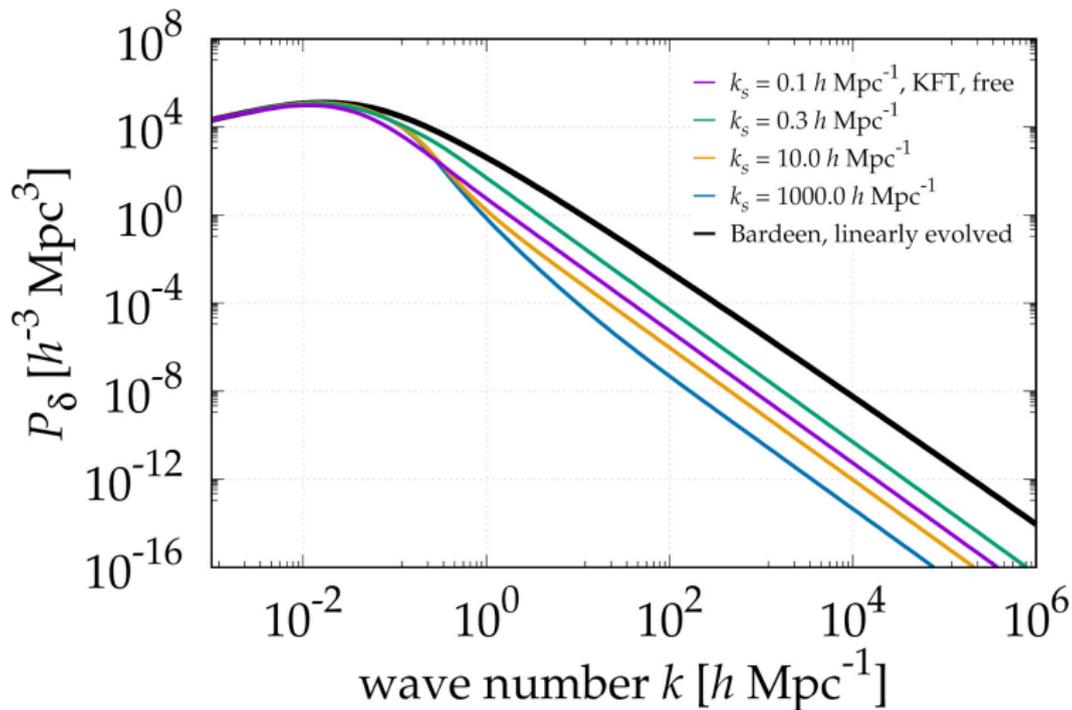


MB et al., SciPost Phys. 10 (2021) 153

$$\mathcal{P}(k) \sim k^{-3}$$

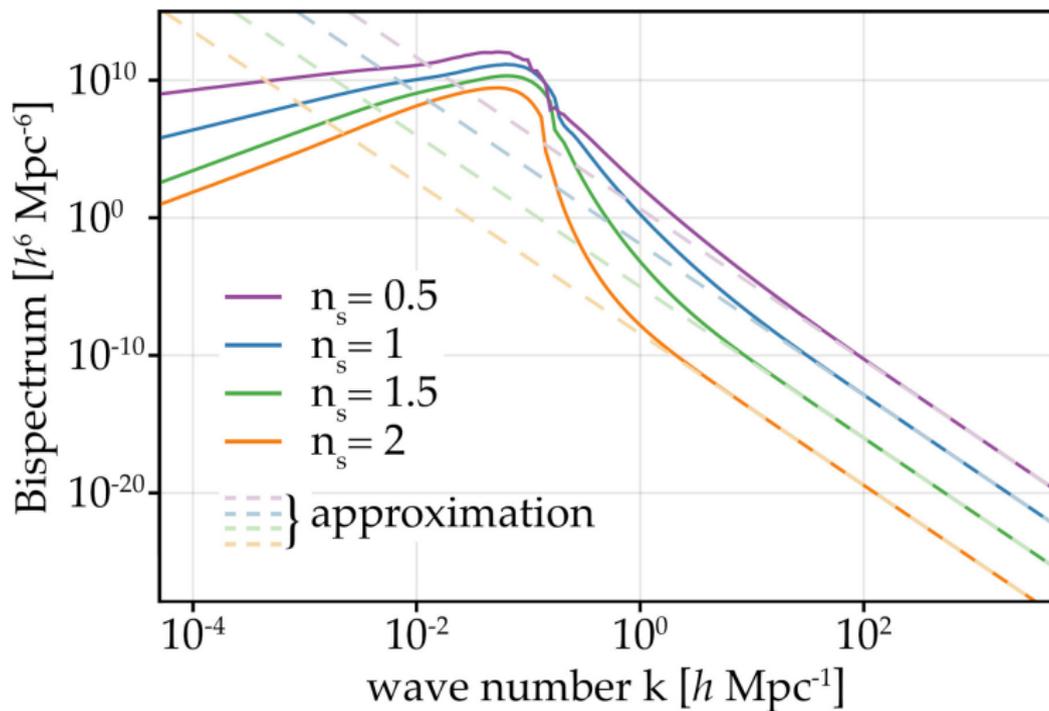
$$B(k_1, k_2, k_3) \sim k^{-11/2}$$

Asymptotic behaviour of free power spectrum



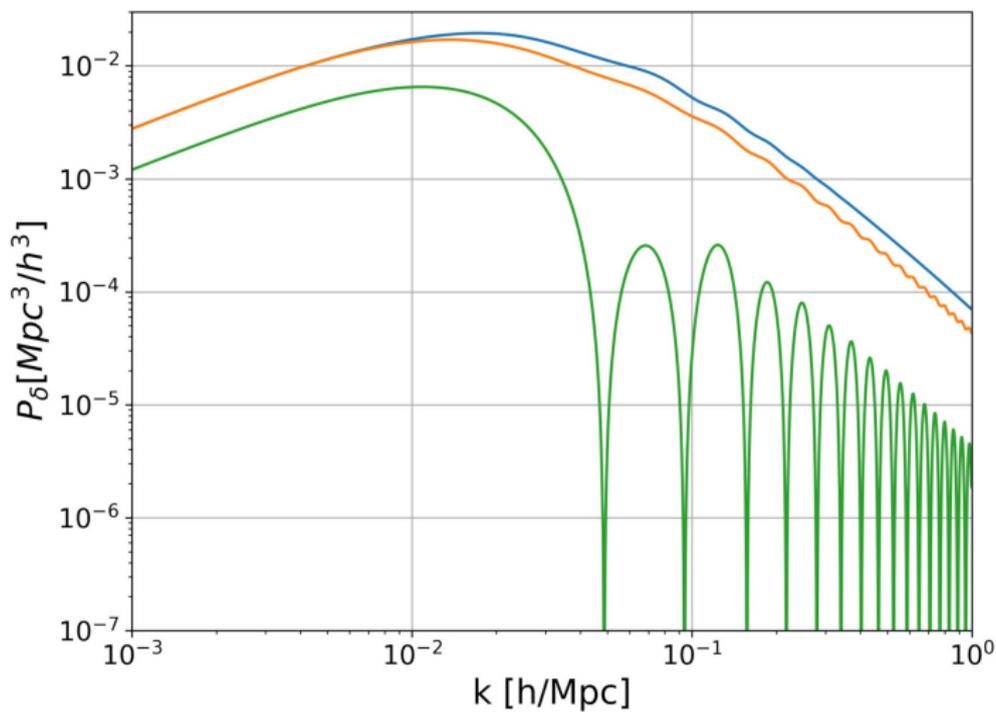
Konrad, S., PhDT; Konrad, S. & MB, arXiv:2104.10028

Asymptotic behaviour of free bispectrum



Waibel, R., MScT; Waibel et al. in prep.

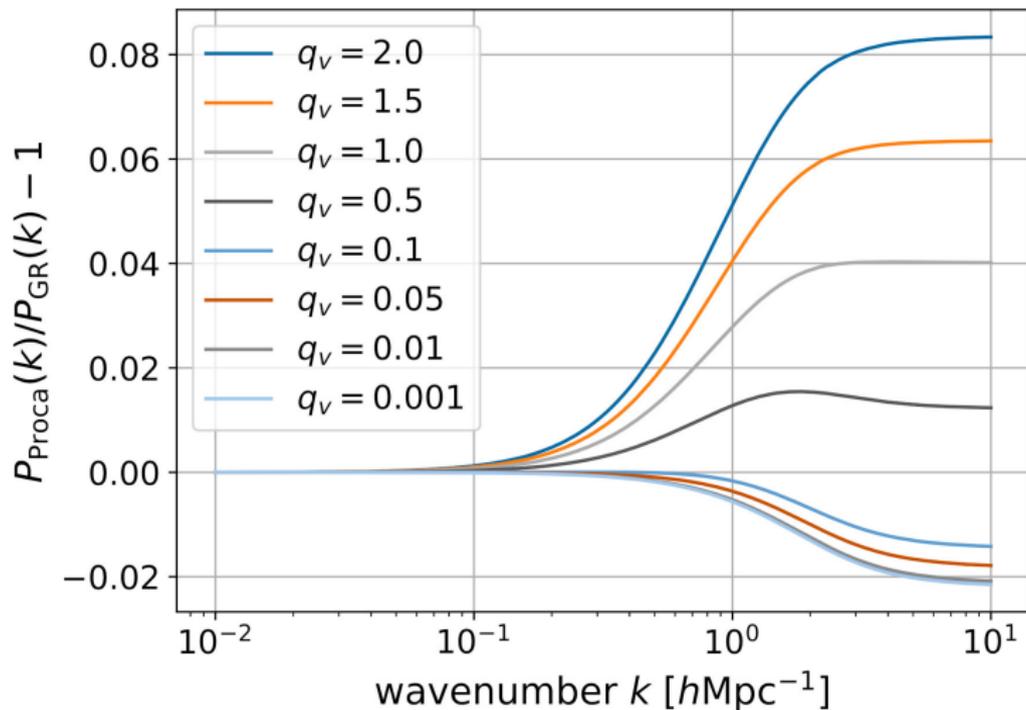
Mixture of dark matter and baryons



Geiss, D. et al. 2019, 2021; Boucsein, M., MScT; Jussios, L., BScT

$$\Delta P_{\delta}^{(\text{nl})}(k) \approx \int_{a_{\min}}^1 dx \left[\frac{\delta P_{\delta}^{(\text{nl})}(k, a)}{\delta E(x)} \Delta E(x) + \frac{\delta P_{\delta}^{(\text{nl})}(k, a)}{\delta G(x)} \Delta G(x) \right]$$

Alternative gravity theories



Oestreicher, A. et al. in prep.; Heisenberg, L. & MB, 2019

- KFT: structure formation in classical particle ensembles in and out of equilibrium, avoids shell-crossing problem
- Systematic approach to perturbation theory, mean-field approximation
- Approximate, accurate equation for non-linear power spectrum
- Asymptotic results for small scales
- Application to mixtures of gas and dark matter reproduces BAOs
- Extension to e.g. generalized theories of gravity

- **Review:** MB et al. 2019
- **Foundations:** Viermann, C. et al. 2015; MB et al. 2016, 2017; Fabis, F. et al. 2018; Dombrowski, J. et al. 2019
- **Mean-field approximation:** MB et al. 2021
- **Relation to SPT (and LPT):** Kozlikin, E. et al. 2021
- **Resummed theory without and with gas:** Lilow, R. et al. 2019; Geiss, D. et al. 2019, 2021
- **Application to generalized gravity:** Heisenberg, L. & MB, 2019