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Breaking $\sum m_\nu$ Parameter Degeneracies with Three-point Statistics

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ABSTRACT

abstract

Keywords: cosmology: —

1. INTRODUCTION

very brief into on neutrinos

Brief intro on the impact of massive active neutrinos on the matter powerspectrum and how that's detectable with CMB and LSS

Quick summary of current constraints and where they come from. Talk about the CMB-LSS lever arm. The degeneracy between As and tau and how that's a bottleneck short thing about how τ is hard to constrain.

Fortunately the imprint of neutrinos on the matter distribution leaves imprints on clustering. So with clustering measurements alone we can derive constraints on $\sum m_\nu$ and at the very least tighten constraints.

Brief summary of previous works that look at the powerspectrum. Then Discuss the shortcomings of the powerspectrum only analysis– Not good enough.

However, we don't have to settle for just two point statistics, three-point statistics such as the bispectrum and 3PCF...

In Section blah

2. HADES AND QUIJOTE SIMULATIONS

We use a subset of the HADES[1] and Quijote simulation suites. The HADES simulations have been run using the GADGET-III TreePM+SPH code (?) in a periodic $(1h^{-1}\mathrm{Gpc})^3$ box. All of the HADES simulations share the values of the following cosmological parameters: Ω_m=0.3175, Ω_b=0.049, Ω_Λ=0.6825, n_s=0.9624, h=0.6711, and $k_\mathrm{pivot} = 0.05\ h\mathrm{Mpc}^{-1}$. These parameters are in good agreement with Planck constraints **?**.

CH: describe quijote simulations

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[1] https://franciscovillaescusa.github.io/hades.html

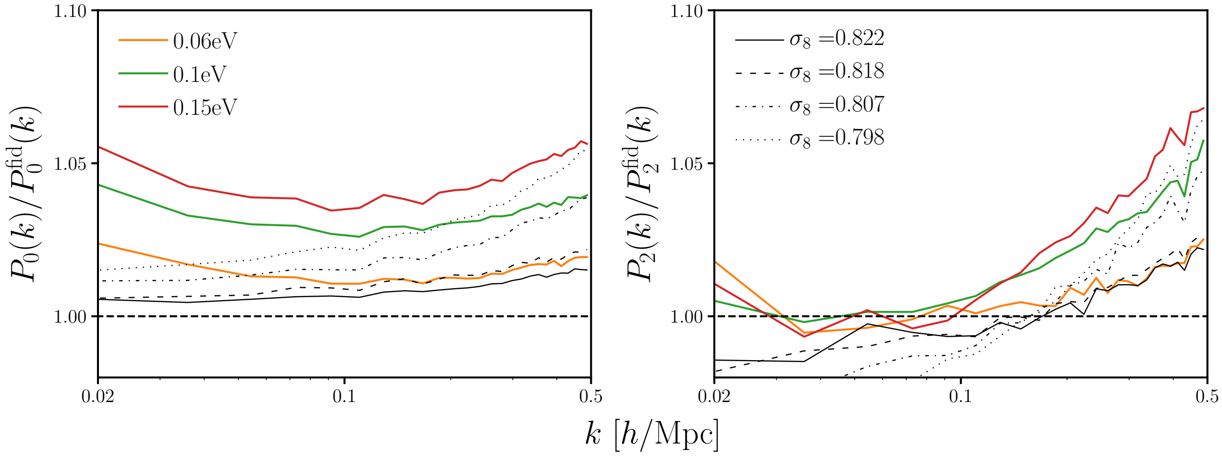


Figure 1. Impact of $\sum m_\nu$ and σ_8 on the redshift-space halo power spectrum monopole and quadrupole. $\sum m_\nu$ and σ_8 produce almost identical effects on halo clustering on small scales ($k > 0.1\,h$/Mpc). This degeneracy can be partially broken through the quadrupole; however, $\sum m_\nu$ *and* σ_8 *produce, within a few percent, almost the same effect on two-point clustering.*

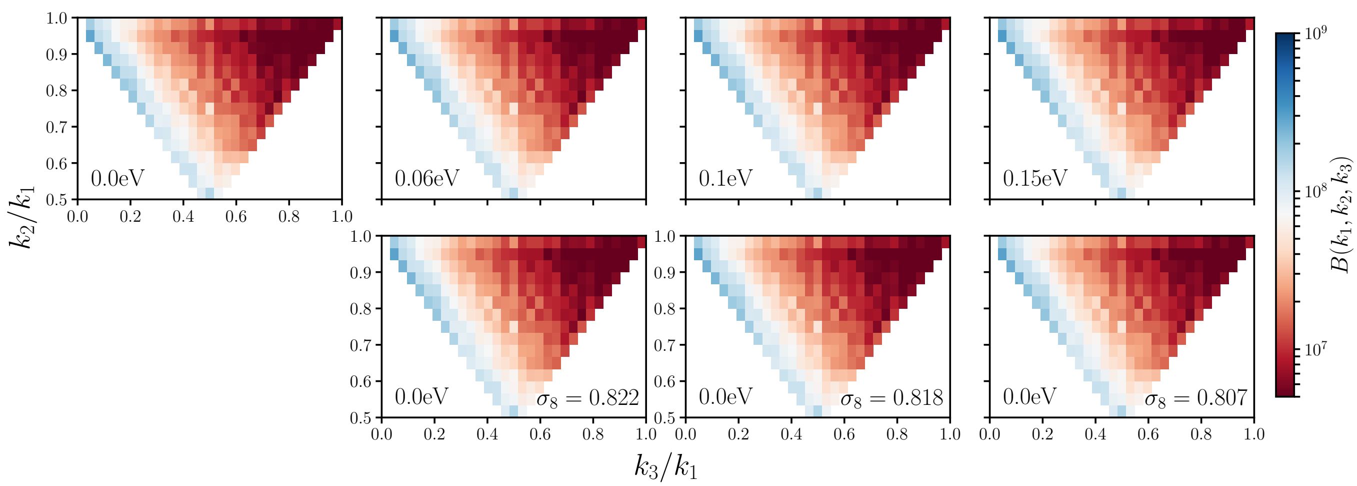


Figure 2. The redshift-space halo bispectrum, $B(k_1, k_2, k_3)$ as a function of triangle configuration shape for $\sum m_\nu = 0.0, 0.06, 0.10$, and 0.15 eV (top panels) and $\sigma_8 = 0.822, 0.818, 0.807$, and 0.798 (lower panels). **CH:** details on the triangle configurations and the colormap. We describe the estimator used to calculate $B(k_1, k_2, k_3)$ in Section 3.

3. BISPECTRUM

Brief description of the Scoccimarro et al. bispectrum estimator here

4. RESULTS

4.1. *Breaking the* $\sum m_\nu$*–* σ_8 *degeneracy*

4.2. *Forecasts*

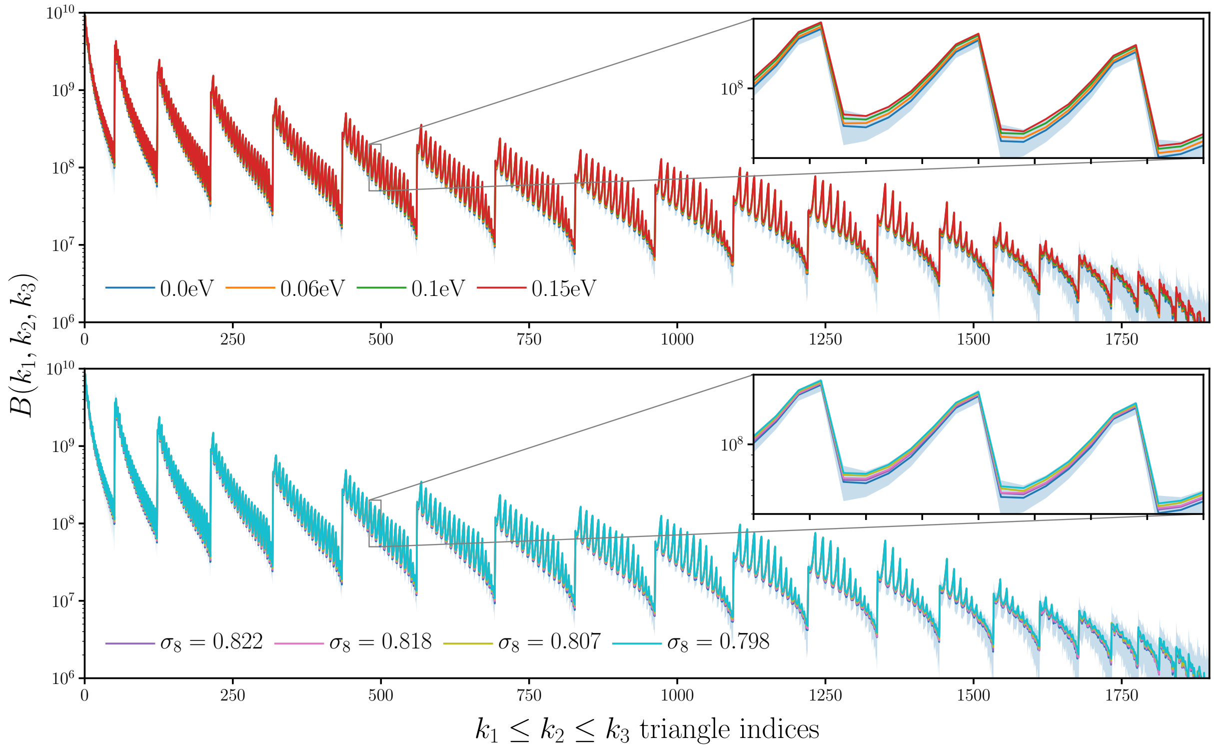


Figure 3. The redshift-space halo bispectrum, $B(k_1, k_2, k_3)$, as a function of all triangle configurations for $\sum m_\nu = 0.0, 0.06, 0.10,$ and $0.15\,\text{eV}$ (top panel) and $\sigma_8 = 0.822, 0.818, 0.807,$ and 0.798 (lower panel). **CH:** details on the ordering of the triangle configurations; also mention how it's roughly scale dependence. We describe the estimator used to calculate $B(k_1, k_2, k_3)$ in Section 3.

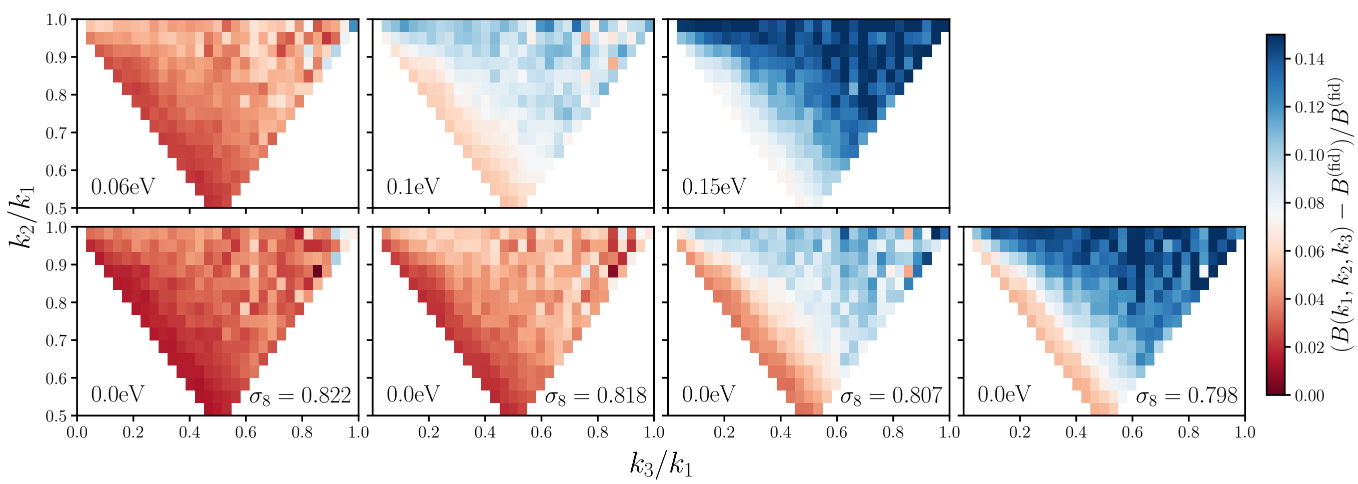


Figure 4. The shape depdence of the $\sum m_\nu$ and σ_8 impact on the redshift-space halo bispectrum, $\Delta B/B^{(\text{fid})}$. $\sum m_\nu = 0.06, 0.10,$ and $0.15\,\text{eV}$ (top panels; left to right) are aligned with $\sigma_8 = 0.822, 0.818,$ and $0.807\,\text{eV}$ (bottom planes; left to right), which produce mostly degenerate imprints on the redshift-space power spectrum. **CH:** Details on the shape dependence. The difference between the top and bottom panels illustrate that $\sum m_\nu$ *induces a sigificantly different impact on the shape-dependence of the halo bispectrum than* σ_8.

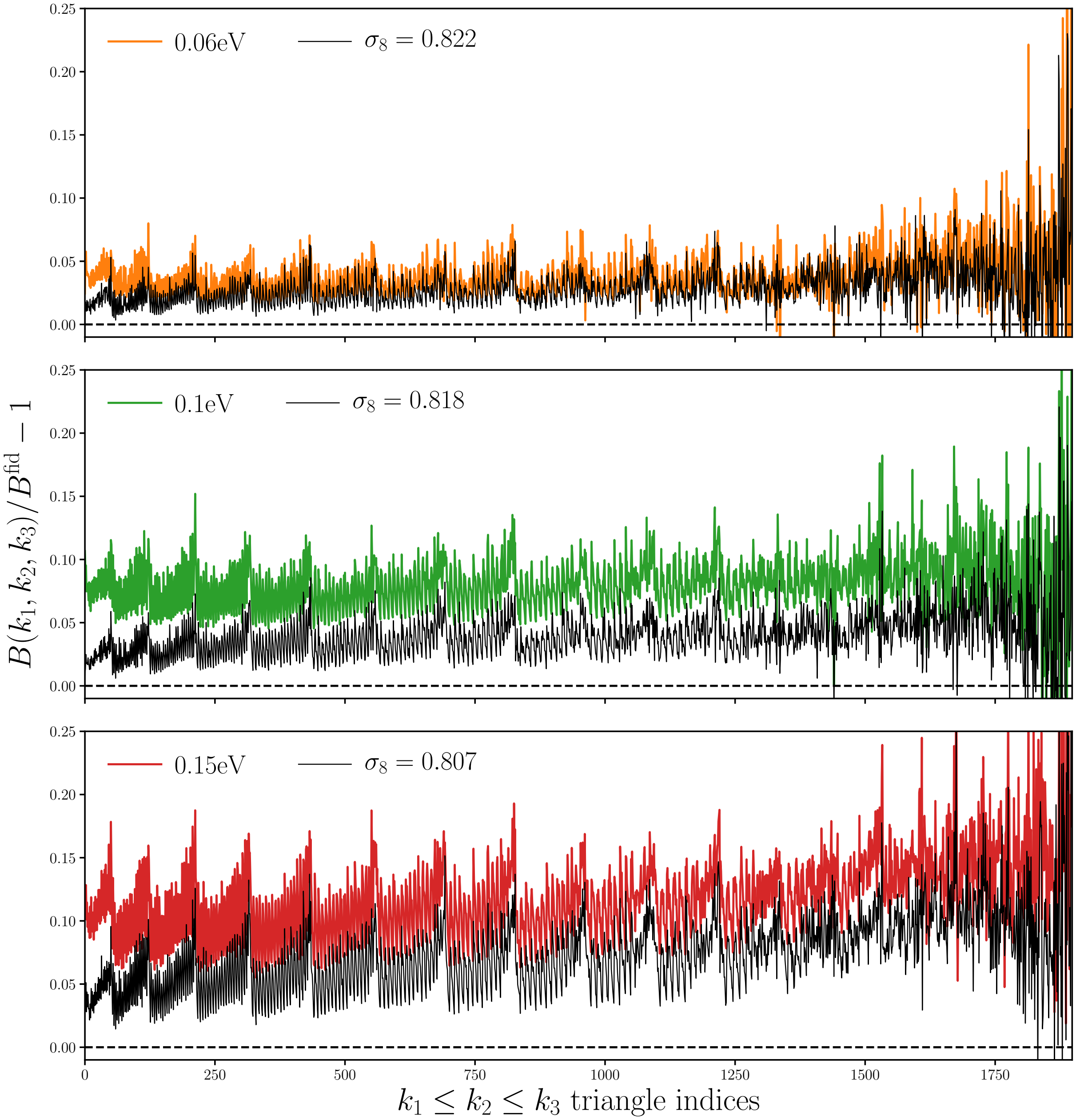


Figure 5. The impact of $\sum m_\nu$ and σ_8 on the redshift-space halo bispectrum for all triangle configurations: $\Delta B/B^{(\rm fid)}$. The impact of $\sum m_\nu$ differs significantly from the impact of σ_8 both in amplitude and scale dependence. For instance, $\sum m_\nu = 0.15\,\mathrm{eV}$ (red) has a $\sim 5\%$ stronger impact on the bispectrum than $\sigma_8 = 0.798$ (cyan dotted), which has little difference in the power spectrum (Figure 1). Combined with the shape-dependence of Figure 4, *the contrasting impact of $\sum m_\nu$ and σ_8 on the redshift-space halo bispectrum illustrate that the bispectrum break the degeneracy between $\sum m_\nu$ and σ_8 that degrade constraints from two-point analyses.*

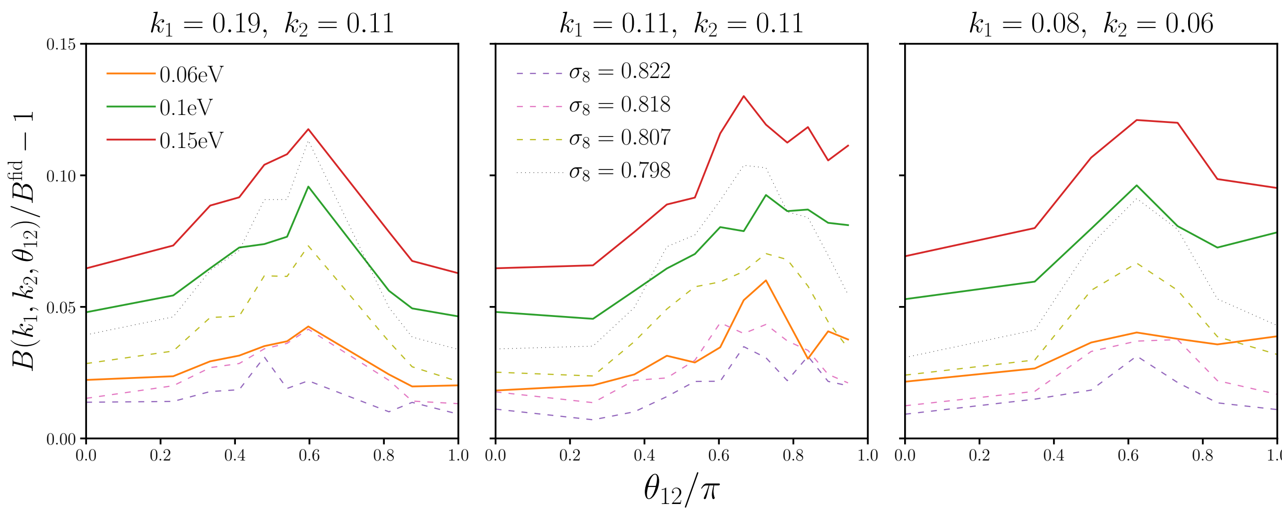


Figure 6.

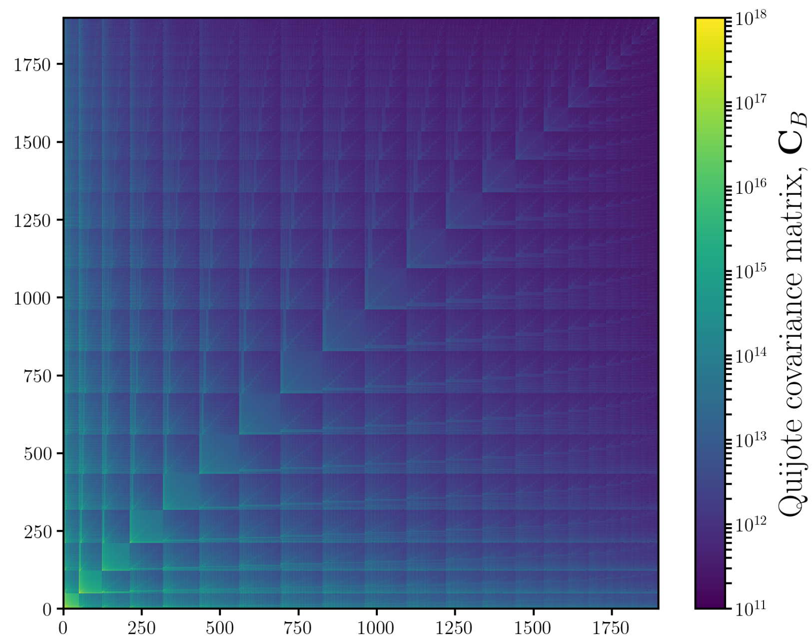


Figure 7. Covariance matrix of the halo bispectrum estimated using 15,000 realizations of the Quijote simulation suite with the fiducial cosmology: $\Omega_{\rm m}$=0.3175, $\Omega_{\rm b}$=0.049, h=0.6711, n_s=0.9624, σ_8=0.834, and $\sum m_\nu$=0.0 eV. **CH:** explain triangle configuration order

5. SUMMARY

ACKNOWLEDGEMENTS

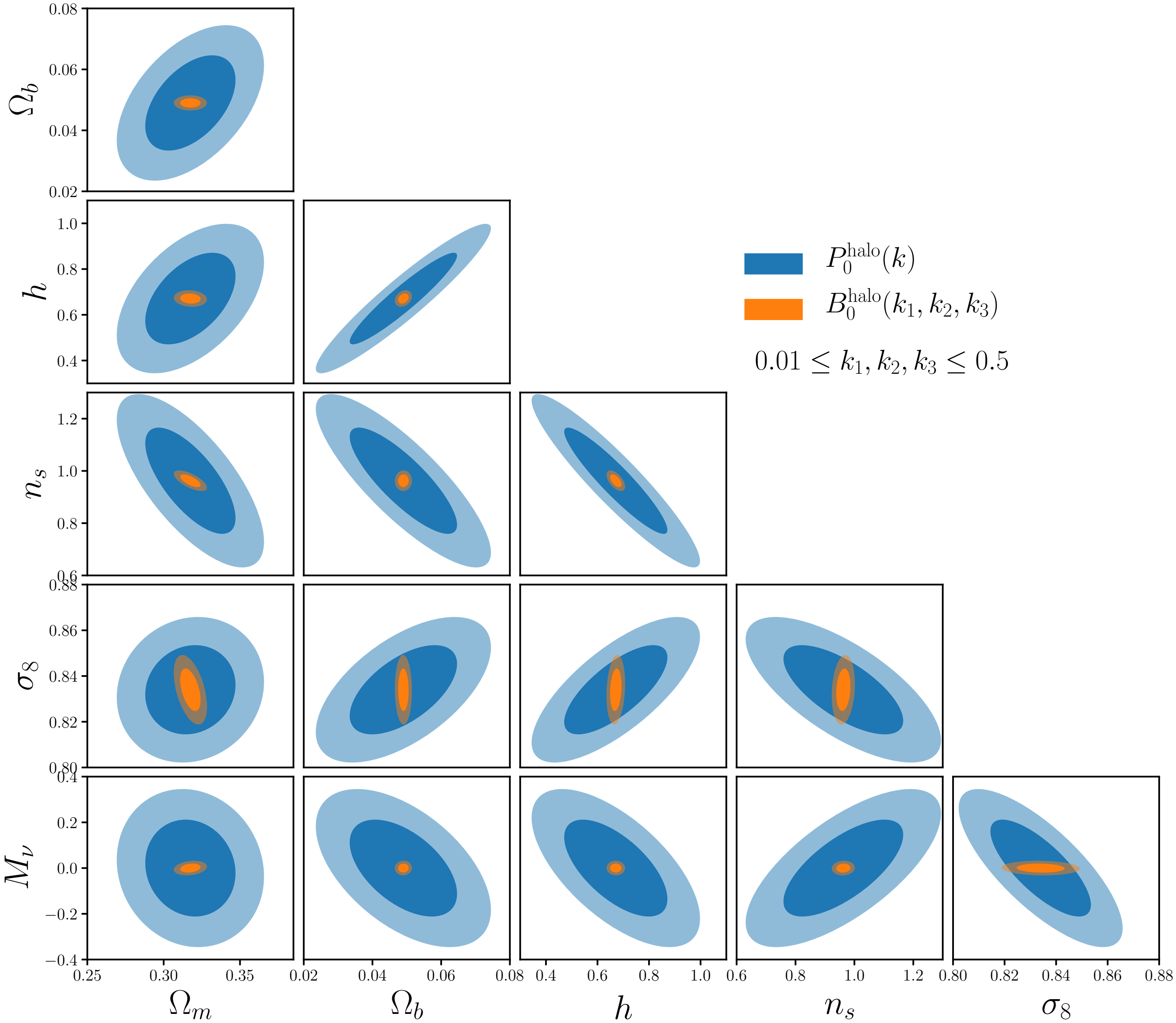
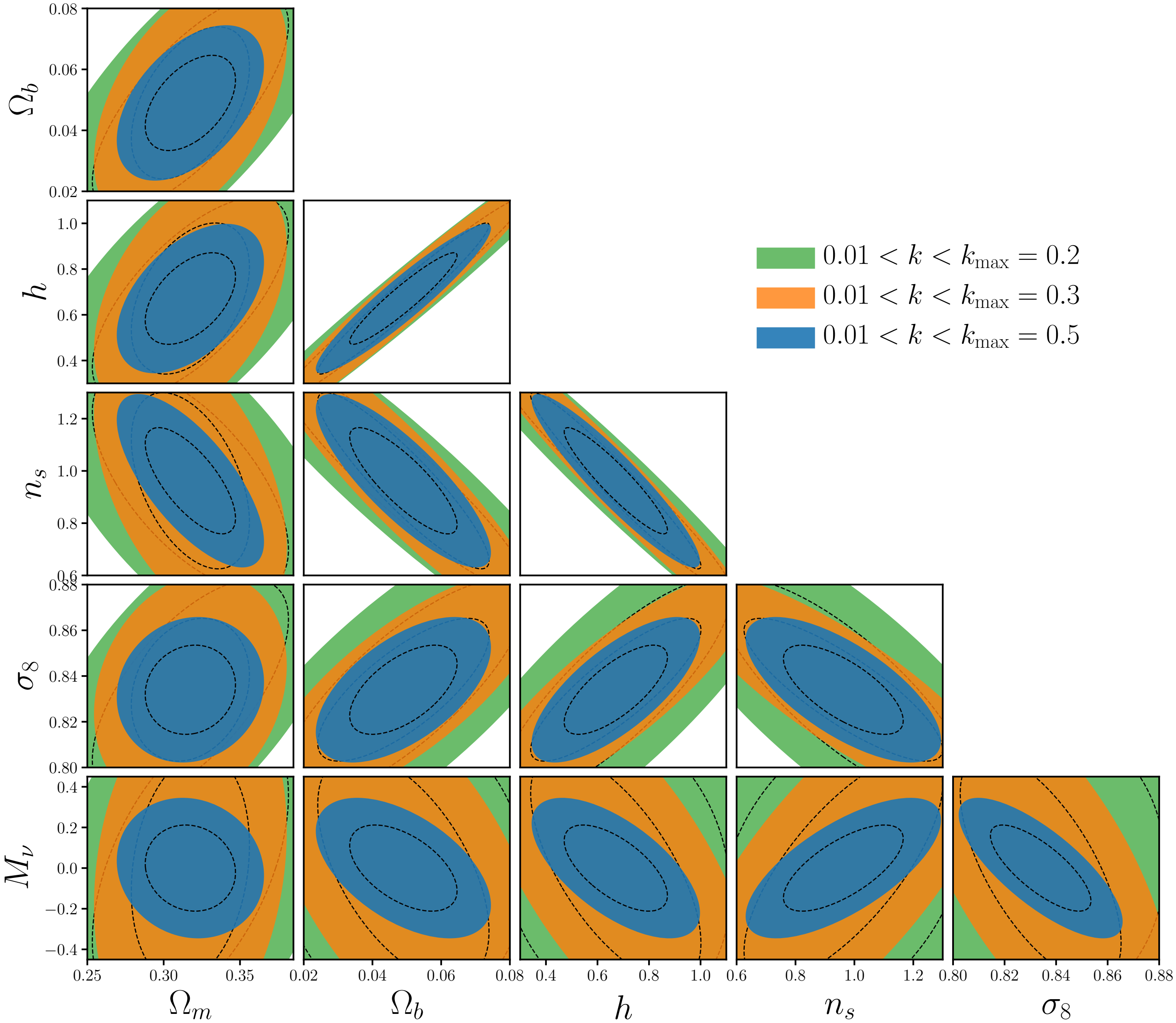


Figure 8.

It's a pleasure to thank Simone Ferraro, Shirley Ho,

APPENDIX

A. TESTING CONVERGENCE



$0.01 < k < k_{\max} = 0.2$
$0.01 < k < k_{\max} = 0.3$
$0.01 < k < k_{\max} = 0.5$
Ω_b
h
n_s
σ_8
M_ν
Ω_m
Ω_b
h
n_s
σ_8

Figure 9.

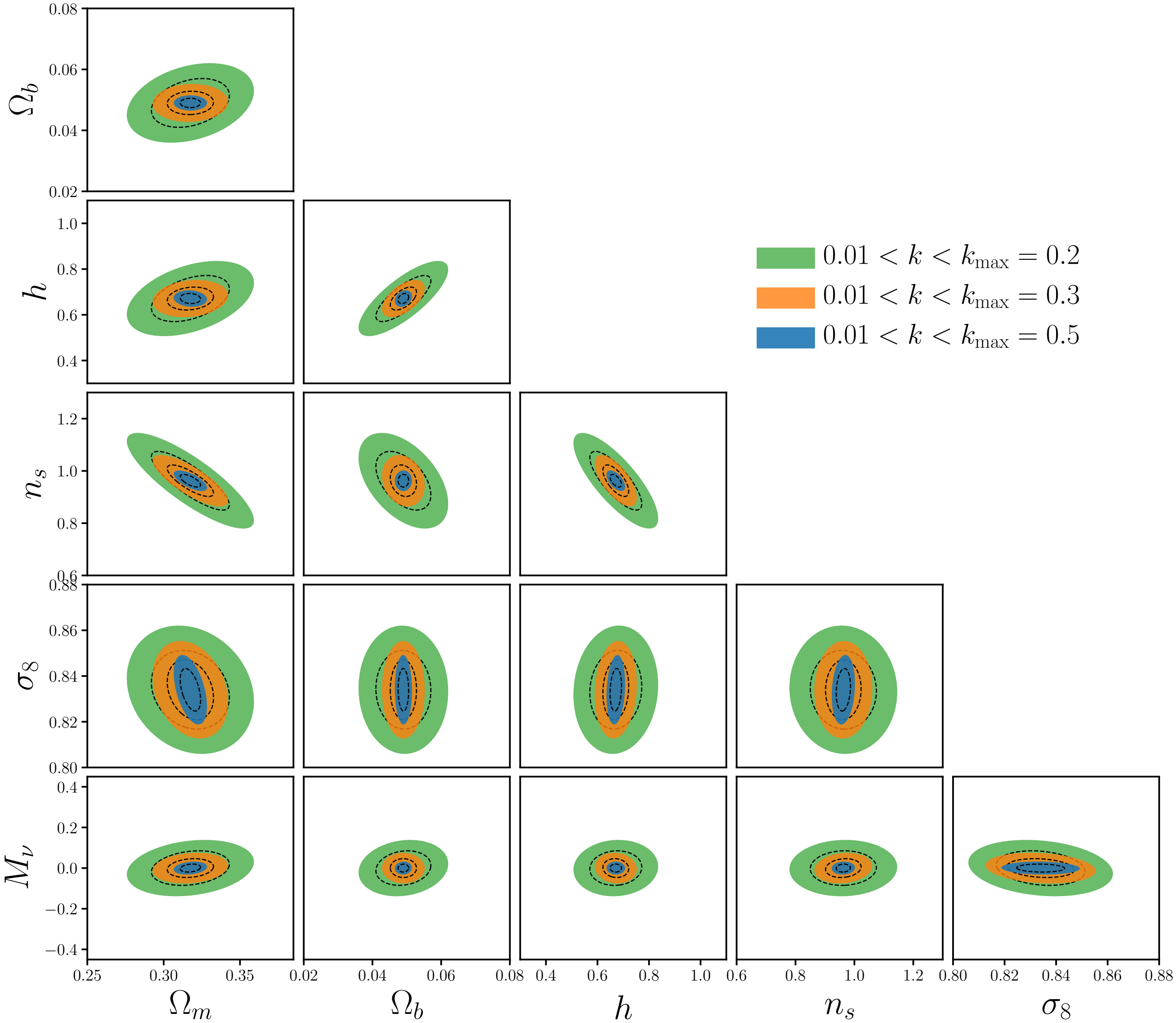

$0.01 < k < k_{\rm max} = 0.2$
$0.01 < k < k_{\rm max} = 0.3$
$0.01 < k < k_{\rm max} = 0.5$
Ω_b
h
n_s
σ_8
M_ν
Ω_m
Ω_b
h
n_s
σ_8

Figure 10.