Evaluating baryonic effects in the Hyper Suprime-Cam Year 3 (HSC-Y3) cosmic shear data on small scales

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Baryonic effect in cosmic shear

Cosmic shear probes matter distribution in the large-scale structure of the universe. The challenge is accurately modeling matter distribution on small scales where possible contamination from baryonic physics exists.

Hydrodynamical simulations show diverge results:

$\sim 20\,\%$ uncertainty in $P_{\rm m}(k)$ (colored lines in Fig. 1)

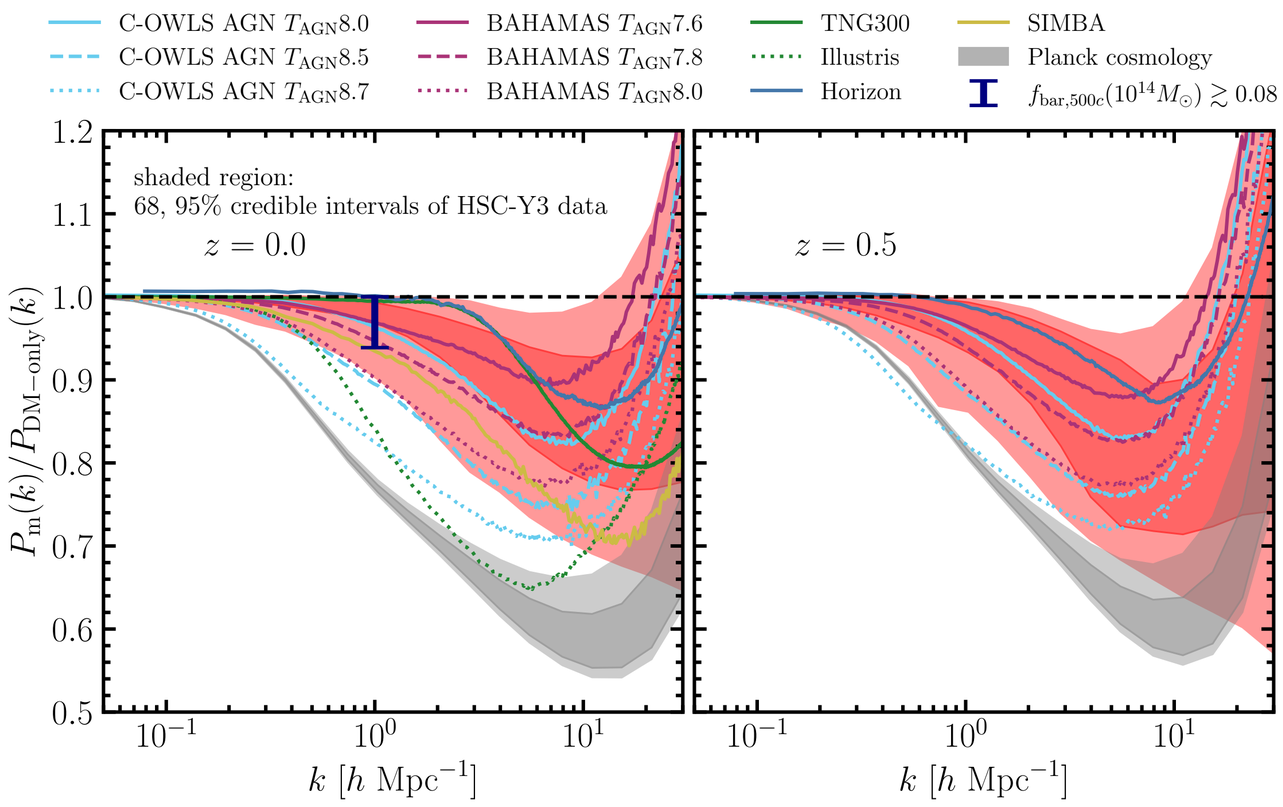

Figure 1: Fractional changes in the matter power spectrum $P_{\rm m}(k)$ due to the baryonic effect.

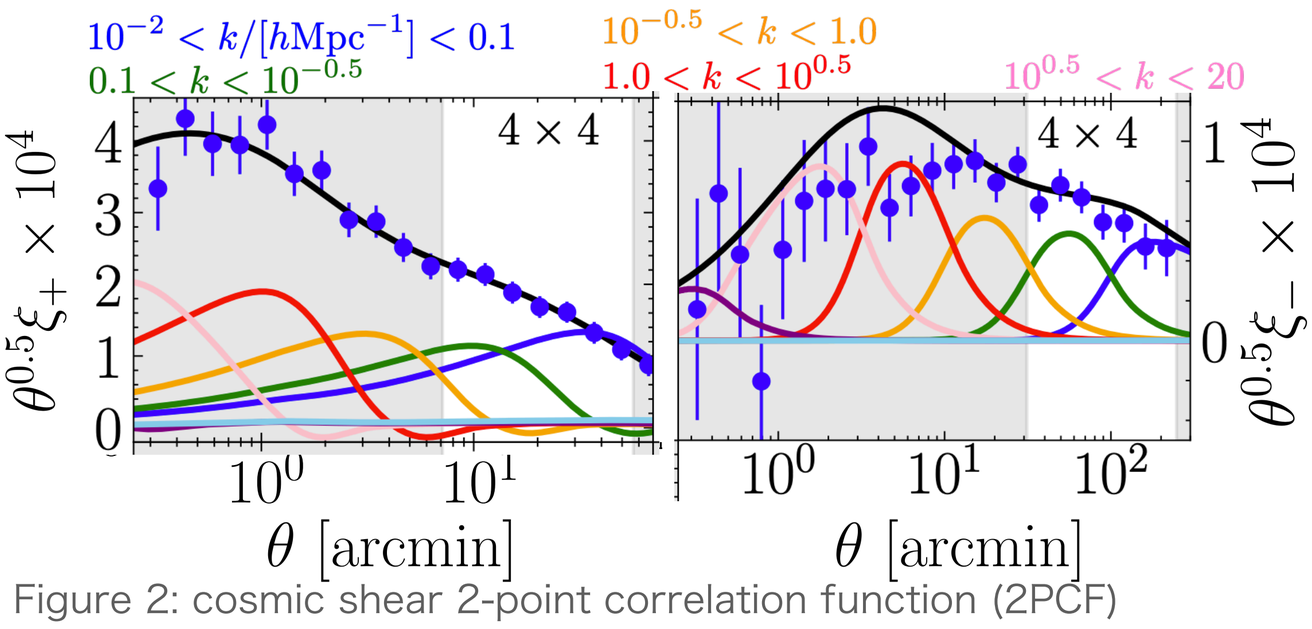

Figure 2: cosmic shear 2-point correlation function (2PCF) measured from HSC-Y3 shape catalog (blue symbols). Colored lines show contributions from the matter power spectrum at certain k-ranges. Shaded regions' data are not used in the HSC-Y3 cosmology analysis in Li+23.

Evaluating baryonic effect by analyzing small-scale data w/ DM-only model

Analyze the data down to small scales with DM-only (DMO) model: if data has strong baryonic effect, the DMO model would fail in either way (or both ways):

1. S_8 is biased lower when using smaller-scale cuts (Fig. 3) → **Results**: No significant shift in S_8 btw different scale-cuts in HSC-Y3 data.
2. The DMO model gives worse fit when using the data down to small scale (Fig. 4), since baryonic effects can not be mimicked by cosmological parameters

→ **Results**: DMO model can fit the data down to smallest scale measured (p-value $= 0.02$ for $\theta_{\rm min} = 0'.28$).

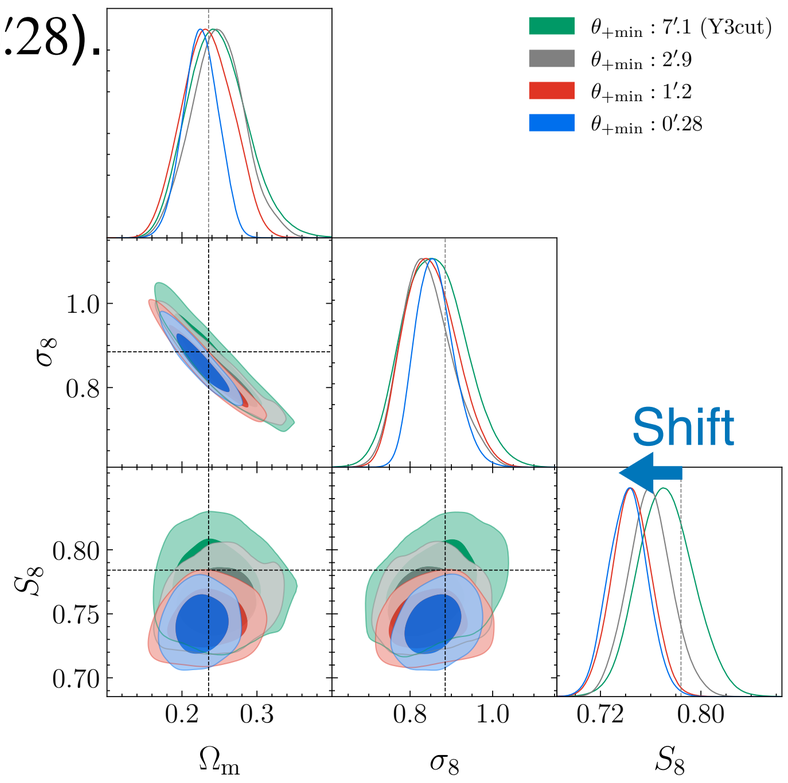

Figure 2: The marginalized posteriors of the analysis of HSC-Y3 -like cosmic shear 2PCFs mock data contaminated with baryonic effect ("BAHAMAS $T_{\rm AGN}8.0$" in Fig. 1): we model the matter power spectrum ignoring the baryonic effect (i.e. DM-only model).

From these findings, we conclude that HSC-Y3 doesn't show the clear signature of baryon, which is consistent with the weak suppression in the matter power spectrum inferred by flexible baryon model analysis (red shaded region in Fig. 1).

Varying growth index γ

As we found the scale-dependent suppression in $P_{\rm m}(k)$ is not preferred by HSC-Y3 data, We then investigate the scale-independent suppression by varying the growth index γ. With joint analysis of primary CMB (Planck PR3), CMB lensing (ACT DR6), cosmic shear (HSC-Y3) and BAO (DESI Y1), We find $> 2\sigma$ deviation from ΛCDM ($\gamma \simeq 0.55$).