Study on wobble impact for component separation

for the LiteBIRD collaboration

Josquin Errard, APC, Jan 2017

Outline

(1) Frequency-independent wobble mismatch angle

(2) Frequency-dependence of wobble cancellation mismatch

(2a) Estimation on the amplitude of the wobble cancelation mismatch for which effects on component separation are detectable

(3) Beam mismatch T->P leakage effect

(4) Conclusion

(1) Frequency-independent wobble mismatch angle

➤ effectively, this is similar to Q/U mixing:

Q, U maps for a given observed frequency

wobble cancellation mismatch angle

Q/U template maps for each component

$$\boxed{\begin{aligned} Q^{\mathrm{obs.\,comp}} \\ U^{\mathrm{obs.\,comp}} \end{aligned}}\begin{aligned} &= \cos(2\delta\theta^{\mathrm{comp}})Q^{\mathrm{comp}} + \sin(2\delta\theta^{\mathrm{comp}})U^{\mathrm{comp}} \\ &= -\sin(2\delta\theta^{\mathrm{comp}})Q^{\mathrm{comp}} + \cos(2\delta\theta^{\mathrm{comp}})U^{\mathrm{comp}} \end{aligned}$$

$$\text{where comp} \in \{\text{synchrotron, CMB, dust}\}$$

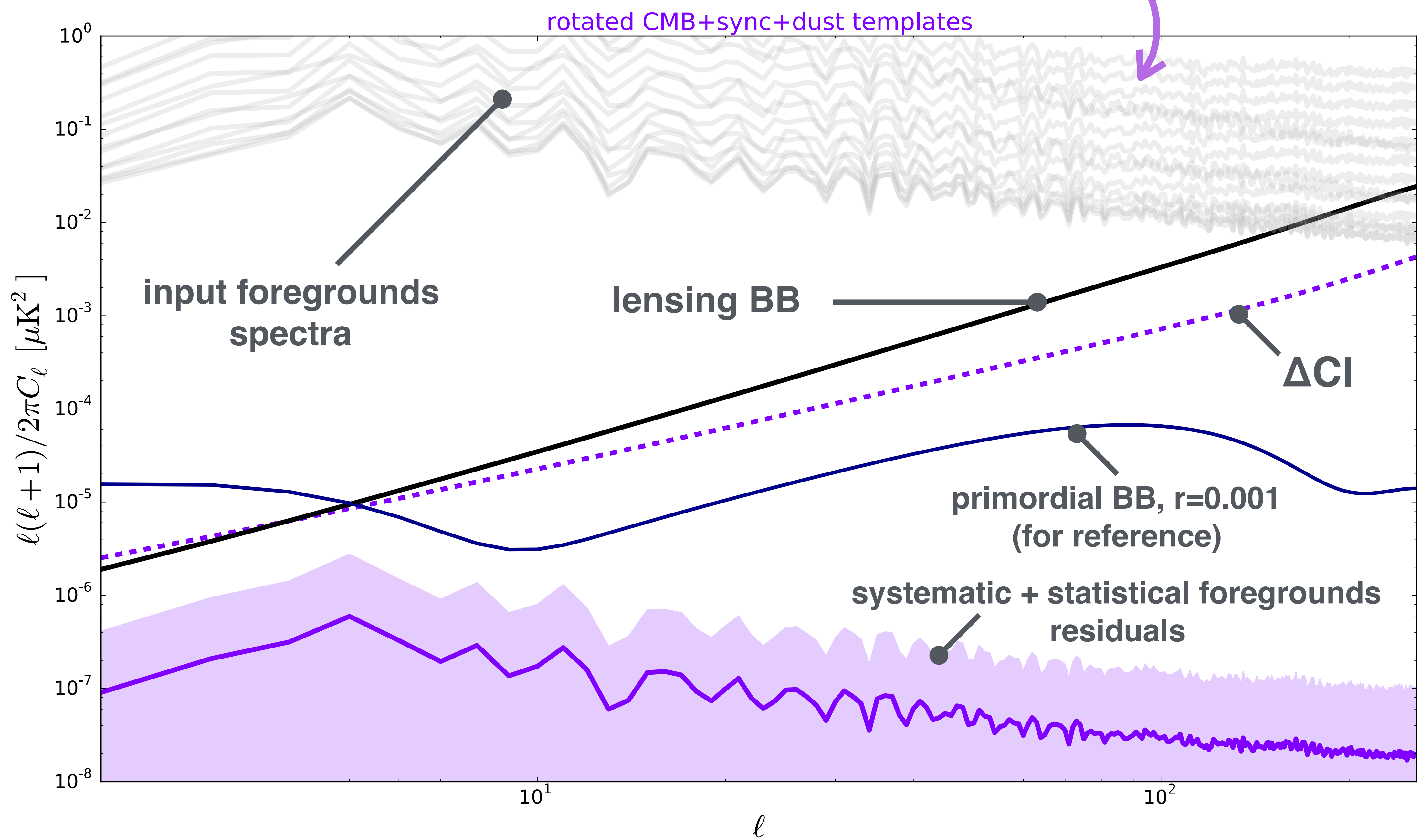
- the $\delta\theta^{\mathrm{comp}}$ is computed from the integral of the wobble angle model, given by θ^{comp} (freq) = 4.7 sin[log(freq) + 4.9], integrated over 30% bandpasses.
- $\delta\theta^{\mathrm{comp}}$ is estimated as the difference between integrated θ^{comp} over 1GHz-shifted bandpasses.
- in the frequency-independent case, $\delta\theta^{\mathrm{comp}}$ is evaluated at 40GHz for synchrotron, 150GHz for CMB and at 400GHz for dust

➤ If wobble mismatch angles are frequency-independent, then there is no significant leakage, no problem in terms of bias on r and just extra but irrelevant variance.

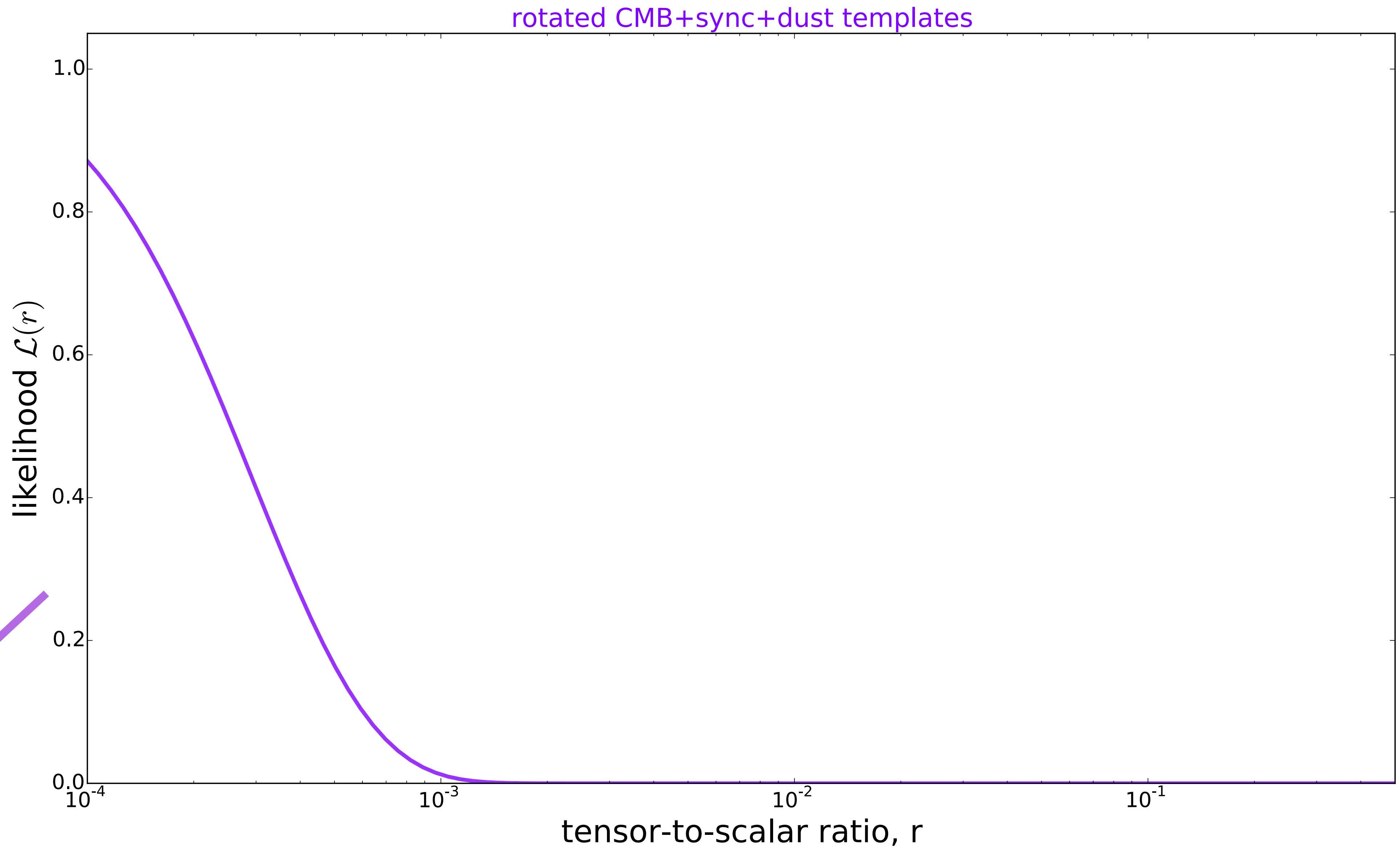
(2) Frequency-dependence of wobble cancellation mismatch

➤ we generate observed frequency maps with synchrotron, CMB and dust (using Planck's foregrounds parameters),and apply rotation angles $\delta\theta^{comp} = \delta\theta^{comp}$ (frequency) for each LiteBIRD frequency band

➤ we estimate the level foregrounds residuals with **xForecast** (Stompor et al, PRD, 2016)



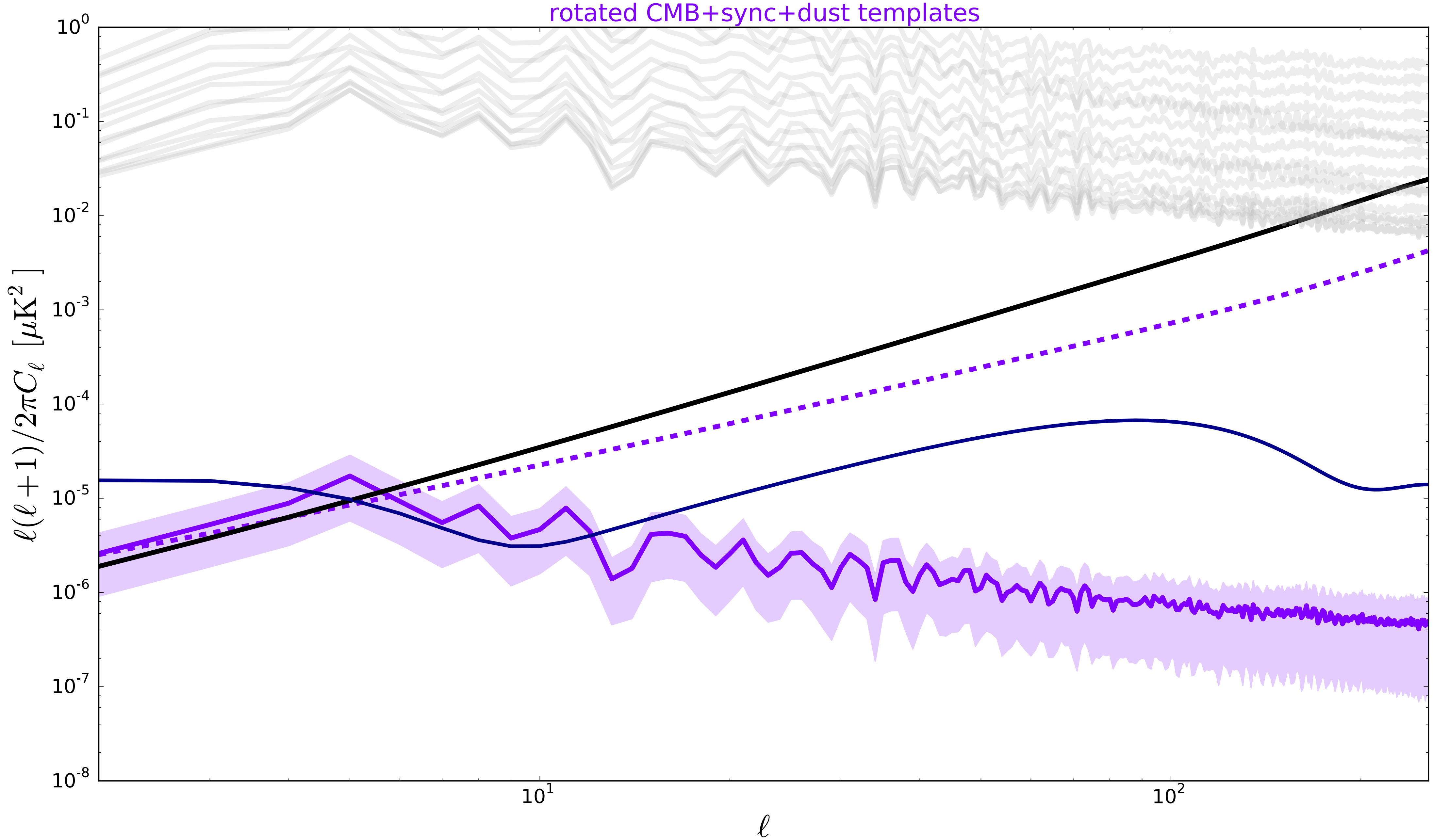
(2) xForecast also estimates the likelihood on tensor-to-scalar ratio, assumed to be r=0 in the simulations. The likelihood takes into account contributions from noise, cosmic variance, as well as statistical and systematic foregrounds residuals.



No bias is observed in the case of frequency-dependent wobble cancellation mismatch.

(2a) In this special case, we extend previous study and multiply each wobble cancelation mismatch angle by an artificial factor 8:

$$\theta^{\mathrm{dust},\,\mathrm{CMB},\,\mathrm{sync}} \times 8$$



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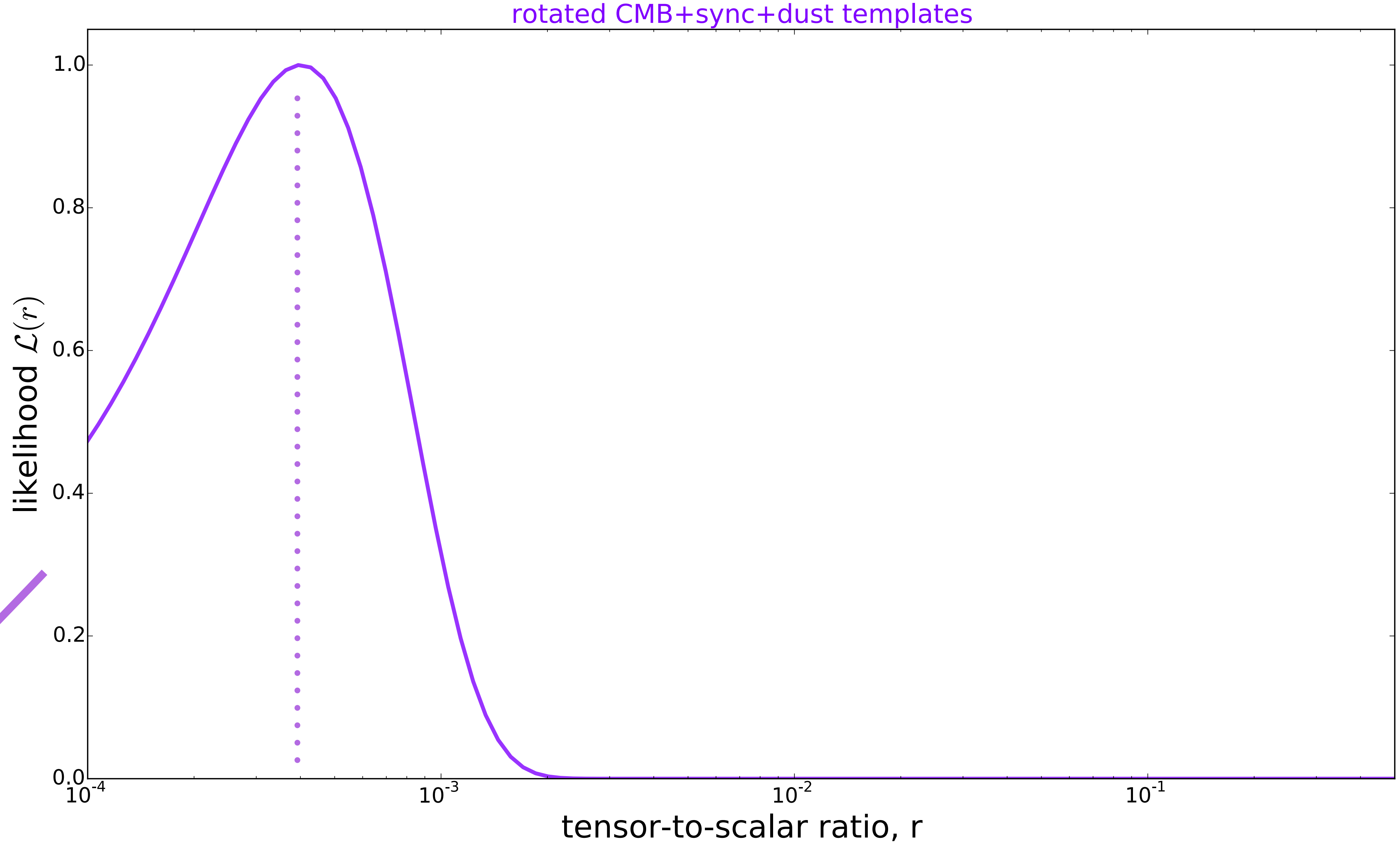
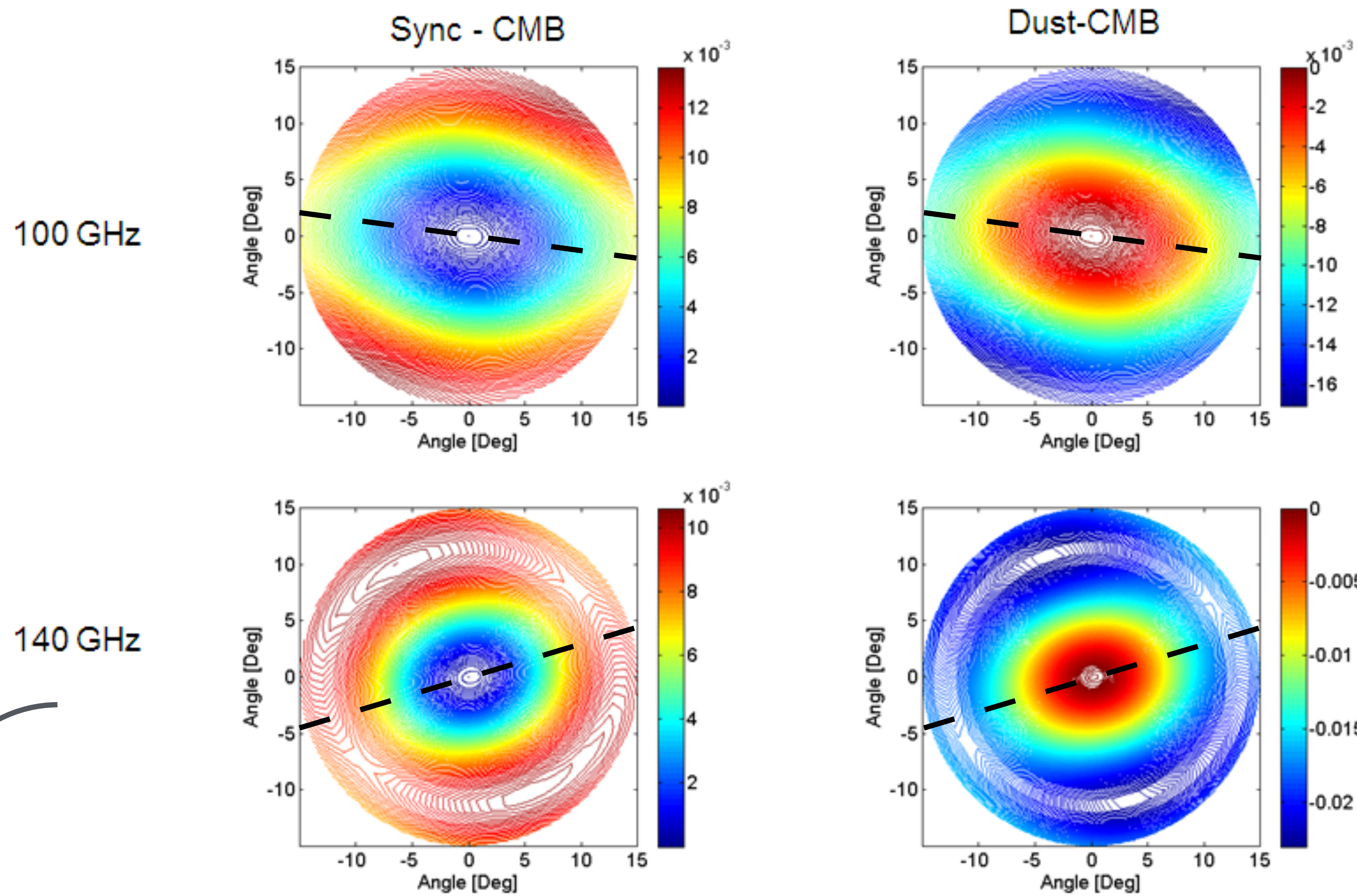


the wobble mismatch angles would have to be 8 times larger than our best estimates to make the bias on r comparable to the 1-σ statistical uncertainty

(3)



frequency-dependent beams leads to elliptical distortion.
This should be equivalent to a wobble cancelation mismatch study summarized in the previous slides

(4) Conclusions

Any of the approaches we investigated indicate that **the effect of wobble cancelation mismatch is under control.**

Caveats: we have not explored full space of foregrounds models, **BUT** we have not explored full space of component separation techniques either, nor tuned the parametric approach in any specific way.