SAT systematics

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Review systematics constraints from CDT

- Abstract description of “additive” vs “multiplicative” systematics
  - Additive systematic acts like unmodeled noise term, can be correlated or uncorrelated across frequencies. Naturally defined in relation to the noise bias.

Table 9: Map-based simulation results for simulations containing systematics. Simulations are as in Table 7 for sky model 3 and $r = 0$, with additive systematic effects in varying combinations, the amplitudes of which are specified as percentages of survey noise.

	Uncorrected		Corrected		ILC		Parametric	
Systematic	A [%]	B [%]	A [%]	B [%]	$\sigma(r) \times 10^4$	r bias $\times 10^4$	$\sigma(r) \times 10^4$	r bias $\times 10^4$
None	0	0	0	0	5.3	0.0	7.2	0.0
Uncorrelated white	3.3	0	0	0	6.0	0.84	8.0	0.63
Uncorrelated $1/\ell$	0	6.8	0	0	5.0	0.99	7.0	0.85
Correlated white	0	0	5.8	0	6.3	1.2	7.3	1.41
Correlated $1/\ell$	0	0	0	10.5	5.2	1.0	6.7	0.97
Uncorrelated white + $1/\ell$ . .	1.6	3.5	0	0	5.6	0.89	7.5	0.76
Correlated white + $1/\ell$	0	0	2.9	5.3	5.5	0.98	6.9	1.04
Both, white + $1/\ell$	0.8	1.7	1.5	2.6	5.6	1.1	7.9	0.98

Review systematics constraints from CDT

- Abstract description of “additive” vs “multiplicative” systematics
  - Additive systematic acts like unmodeled noise term, can be correlated or uncorrelated across frequencies. Naturally defined in relation to the noise bias.
  - Multiplicative error mis-scales signals in the map. Considered the example of bandpass error, which affects our ability to identify / separate foregrounds. Bias on r varies depending on whether these errors are correlated across observing frequencies ***and the analysis method.***

> Results of simulating systematic errors in the determination of bandpasses vary by analysis method. The construction of the ILC method makes it largely insensitive to such errors. The parametric analysis, which includes parametrized models of the frequency spectra of different foregrounds, shows biases on r at the 1×10^{-4} level for uncorrelated random deviations in bandcenter determination of 0.8%, or for correlated deviations of 2%, which we adopt as reasonable benchmark requirements to accommodate a variety of both blind and astrophysical foreground modeling approaches.

Estimated systematics from BKIII: Instrumental Systematics (arXiv:1502.00608)

Very challenging to predict systematics a priori, but to the extent that CMB-S4 looks like past / current experiments, we can use those for guidance.

CMB-S4 sigma(r) target is 5e-4, so the first six items on this list would all be major problems!

Critical to understand how these effects will scale with detector count -- is the additive systematic power scales as 1/Ndet, then it will be remain a constant fraction of the noise bias.

TABLE 4
INSTRUMENTAL SYSTEMATICS

Systematic	Characteristic r
crosstalk	$\simeq 3.2 \times 10^{-3}$
beams (including gain mismatch)	$< 3.0 \times 10^{-3}$
EMI	$< 1.7 \times 10^{-3}$
cross polar response	$< 10^{-3}$
detector transfer functions	$< 5.7 \times 10^{-4}$
systematic polarization angle error	$< 4.0 \times 10^{-4}$
gain variation $E \to B$	$< 5.3 \times 10^{-5}$
random polarization angle error	$< 5.0 \times 10^{-5}$
thermal fluctuations	$< 1.2 \times 10^{-5}$
ghost beams	$\simeq 7.2 \times 10^{-6}$
scan synchronous contamination	$< 1 \times 10^{-8}$
Total	$\simeq (3.2 - 6.5) \times 10^{-3}$

NOTE. — The comparable characteristic r of BICEP2's statistical uncertainty is $r = 3.1 \times 10^{-2}$.

Path forward

Systematics results from past / current experiments (tables from BICEP, others?) provide guidance on priority, magnitude, and form of systematics.

Try to retain original framework of additive vs multiplicative systematics.

Highly cross-cutting activity -- intersections with flowdown, SAT (esp. calibration), detectors/readout/modules, sites/EMI, and data management (for analysis mitigation and perhaps sims).

Recent discussion with Jeff McMahon, John Ruhl re: developing map-based tools to enable some types of systematics investigation.