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A minimal power-spectrum-based moment expansion for CMB B-mode searches.

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The characterization and modelling of polarized foregrounds has become a critical issue in the quest for primordial B-modes. A typical method to proceed is to factorize and parametrize the spectral properties of foregrounds and their scale dependence (i.e. assuming that foreground spectra are well described everywhere by their sky-averaged spectrum). Since in reality foreground properties vary across the Galaxy, this assumption leads to inaccuracies in the model that manifest themselves as biases in the final cosmological parameters (in this case the tensor-to-scalar ratio). This is particularly relevant for surveys over large fractions of the sky, such as the Simons Observatory (SO), where the spectra should be modelled over a distribution of parameter values. Here we propose a method based on the existing "moment expansion" approach to address this issue in a power-spectrum-based analysis that is robust to other sources of instrumental uncertainty. Additionally, the method uses only a small set of parameters with simple physical interpretation, minimizing the impact of foreground uncertainties on the final B-mode constraints. We validate the method using SO-like simulated observations, recovering an unbiased estimate of the tensor-to-scalar ratio r with standard deviation $\sigma(r) \simeq 0.003$, compatible with official forecasts. When applying the method to the public \bicep{} data, we are able to recover constraints on r that follow closely those found by BICEP2/Keck Array in the presence of a scale-independent frequency decorrelation parameter.

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