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Joint Bayesian calibration and map-making for intensity mapping experiments

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This work presents a framework for joint calibration and map-making using Gibbs sampling. Instead of conditioning on a fixed noise level, our data model employs multiplicative noise as a direct application of the radiometer equation, accurately capturing the coupling between noise level and system temperature. To enable unbiased and fast estimation of gain and system temperature, we develop an iterative GLS sampling method. Absolute flux calibration can be achieved either with external sources or internally using known signal injections, such as noise diodes. To handle correlated noise, we introduce a proper $1/f$ noise model that avoids spurious periodic correlations in the time domain caused by the conventional assumption of diagonal DFT noise covariance. Furthermore, we implement this workflow in an efficient software package, leveraging the Levinson algorithm to reduce the computational complexity of noise parameter sampling to O(N^2), ensuring good scalability. Although this workflow is demonstrated for auto-correlation measurements, the strategies and techniques can also be applied to cross-correlation measurements by ignoring the correlated noise but taking an extra multiplicative gain in the data model.

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