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Bayesian inverse problem with scattering transform : application to instrumental decontamination

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Decontaminating a signal of interest is a recurring challenge in astrophysics and cosmology. Given the stochastic nature of usual contaminations (for instance instrumental, or from cosmological background or Galactic foregrounds), it can be framed as an ill-posed inverse problem. A Bayesian approach is needed to recover a distribution of signals compatible with the observed data. We propose a method to estimate clean signal statistics from a single contaminated observation, assuming only that the signal of interest is well described by a maximum entropy distribution conditioned on scattering transform statistics, and that we are able to sample the contamination distribution. It uses generative modelling conditioned on scattering transform statistics to estimate a simple mapping between clean and contaminated signals in the scattering statistic' s space. Validated on large-scale structure maps with a complex instrumental contamination model (beam + noise + masks), our approach recovers a posterior distribution of key astrophysical statistics—power spectrum, PDF, and Minkowski functionals—down to an order of magnitude below the contamination level.

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