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Diffusion-Based Separation of CMB and Dust Emission: Enabling Cosmological Inference

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The quest for primordial B-modes in cosmic microwave background (CMB) observations requires a refined model of the Galactic dust foreground. We investigate diffusion-based models of the dust foreground and their interest for both component separation and cosmological inference. First, under the assumption of a Gaussian CMB with known cosmology, we show that diffusion models can be trained on examples of dust emission maps in such a way that their sampling process directly coincides with posterior sampling in the context of component separation. We illustrate this on additive mixtures of dust emission maps produced from a magnetohydrodynamic simulation, and simulated CMB maps for a standard cosmology. Usual summary statistics (pixel distribution, power spectrum, Minkowski functionals) of the components are well recovered by this process. Second, in a context where the CMB cosmology is unknown, we train a diffusion model enabling posterior sampling conditioned on arbitrary cosmologies. We finally describe two independent methods leveraging this model for cosmological inference. If proven successful in future work, these methods would allow cosmological inference from a mixture of dust emission and CMB assuming any kind of dust prior.

Brainstorming idea [title]

Diffusion Models for Cosmological Inference

Brainstorming idea [abstract]

To what extent can diffusion models be used for cosmological inference from cosmological data (e.g. galaxy surveys, CMB observations)? Can diffusion models be integrated in simulation-based inference frameworks?

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