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Radio-astronomical Image Reconstruction with Conditional Denoising Diffusion Model

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Reconstructing accurate sky models from dirty radio images is crucial for advancing high-redshift galaxy evolution studies, especially when using ALMA. Existing pipelines often employ CLEAN algorithms followed by source detection methods. However, these pipelines struggle in low-SNR scenarios and cannot directly apply to idealized, noise-free sky models.

We present a novel framework that uses stochastic neural networks for the direct reconstruction of sky models from dirty images. This approach not only enhances the accuracy of source localization and flux estimation but also integrates built-in uncertainty measures. Importantly, we introduce invertible normalization techniques specifically tailored for sky models and explore their impact.

We validated our method on a dataset of ALMA images simulated with CASA. Source extraction from predicted sky models was performed using Photutils, and performance variations were assessed under different Precipitable Water Vapor (PWV) conditions.

Our framework achieves 90% completeness in source representation at low SNR levels and accurately estimates fluxes in reconstructed sky models. While performance declines when testing and training PWV conditions differ, our method fills gaps unaddressed by existing pipelines such as CLEAN-based approaches.

Brainstorming idea [title]

Stochasticity in Denoising Diffusion Probability Models

Brainstorming idea [abstract]

Stochasticity in Denoising Diffusion Probability Models

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