Contribution ID: **133** Type: **Poster + Flashtalk**

Maria Goes Nifty - Simulation, Gaussian Process-Based Reconstruction and Denoising of (Sub-)Millimetre Single-Dish Telescope Data

(Sub-)millimeter single-dish telescopes offer two key advantages compared to interferometers: they can efficiently map larger portions of the sky, and they can recover larger spatial scales. Nonetheless, fluctuations in the atmosphere, the dominant noise source in ground-based observations, limit the accurate retrieval of signals from astronomical sources. We introduce maria (https://thomaswmorris.com/maria/), a versatile, python-based general-purpose simulator for microwave and radio telescopes. Maria generates location-specific weather with accurate turbulence, allowing an in-depth study of optimal removal of the atmosphere in astronomical data. We generate synthetic observations from simulations that account for both atmospheric signal and filtering effects by letting the input array scan in a pre-defined scanning pattern over the astronomical background through the simulated turbulent and evolving atmosphere. The synthetic data are used to optimize the transfer function and various calibration techniques, from which the astronomical map is reconstructed using the Numeric Information Field Theory (NIFTy, https://ift.pages.mpcdf.de/nifty/) package. The contributions from the map and atmosphere to the time series data are described by separate gaussian process models, allowing for a separation and accurate reconstruction of both components. Noise contributions from the detectors and other sources are removed in the reconstruction process. We observe that the NIFTy-based approach leads to a significantly improved map reconstruction for simulated data, while providing an uncertainty quantification of the results. The application of the NIFTy-based reconstruction method to simulated observations by the 50 m Atacama Large Aperture Submillimeter Telescope (AtLAST) is discussed, as well as the possibility to reconstruct CMB contributions.

AI keywords

gaussian process, variational inference, Bayesian inference, uncertainty

Primary authors: WÜRZINGER, Jonas (Technical University of Munich); VAN MARREWIJK, Joshiwa (Leiden Observatory, Leiden University); FUCHS, Richard (Technical University of Munich); MORRIS, Thomas (Yale University & Brookhaven National Laboratory); MROCZKOWSKI, Tony (European Southern Observatory (ESO))

Presenter: WÜRZINGER, Jonas (Technical University of Munich)

Track Classification: Patterns & Anomalies