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REDUCING THE RUN TIME OF MCRT SIMULATIONS WITH HELP OF INLA

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Monte Carlo radiative transfer (MCRT) simulations have proven to be an important technique for comprehending the role of dust on astrophysical systems and its effects on observations. These simulations use a large number of photon packages to mimic the propagation of real photons in dusty environments, taking into account physical processes such as scattering, absorption, and thermal re-emission by dust grains. However, simulations of realistic 3D inhomogeneous dust distributions are computationally challenging.

We develop a novel technique for post-processing MCRT output capable to achieve the quality of high photon number images using computationally less expensive simulations of lower-quality images as an input. We combine principal component analysis (PCA) and non-negative matrix factorization (NMF) as dimensionality reduction techniques together with Gaussian Markov random fields and the integrated nested Laplace approximation (INLA), an approximate method for Bayesian inference, to detect and reconstruct the non-random spatial structure in the images of lower signal-to-noise ratios or with missing data.

We test our methodology using different MCRT images and show that with this approach we are able to reproduce high photon number reference images ~ 5 times faster with median residuals below $\sim 20\%$.