

RESOLVE: ALTERNATIVE BAYESIAN APPROACH TO CLEAN

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ABSTRACT

Radio interferometry, the method of interfering radio waves to produce spectra, provides higher resolution and sensitivities by increasing the aperture of the constituent antenna. Mathematical signal processing techniques are then applied to the subsequent spectra in order to construct high-resolution images. The dirty image is constructed from the intensity function via convolution between the visibility function and sampling function. This is computationally expensive, as the visibility function does not continuous span the Fourier space (u,v).

The CLEAN method (Högbom 1974)^{a)} has been the de-facto algorithm to recover high-resolution images from the dirty images. While this method has been modified and advanced numerous, the underlying assumption is the image is composed of a combination of uncorrelated point sources. There have been new implementations in order to address these concerns: reducing computation effort (Clark 1980)^{b)}, improving multi-frequency synthesis (Sault & Wieringa 1994)^{c)}, and corrections (Schwab 1984)^{d)}.

RESOLVE was created to overcome this by fulfilling two main objectives: it should be optimal for diffuse sources and reliably include uncertainty propagation/error estimation during image reconstruction. RESOLVE, a Bayesian algorithm, has to compute the Fourier transform of the sky intensity numerous times to propagate the error through reconstruction. This is computationally expensive, causing RESOLVE to take longer to compute than CLEAN^{e)}. However, the resulting image from RESOLVE boast variable resolution, based on local signal-to-noise which, at worst cases, is comparable to the uniform weighting method of CLEAN in terms of the quality of the recovered image. RESOLVE proposes a new method of cleaning extended sources over the standard CLEAN, while offering higher resolutions and sensitivities. Our group has rigorously implemented the CLEAN algorithm, however the RESOLVE algorithm could offer a robust method of non-interactive reconstructions of radio interferometric data.

^{a)} Högbom, J. A. 1974, A&AS, 15, 417

^{b)} Clark, B. G. 1980, A&A, 89, 377

^{c)} Sault, R. J. & Wieringa, M. H. 1994, A&AS, 108

^{d)} Schwab, F. R. 1984, ApJ, 89, 1076

^{e)} CLEAN methods are interactive, RESOLVE methods are autonomous. So complete time analysis is difficult