

BAYESIAN INTERFEROMETRIC IMAGE RECONSTRUCTION

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I will discuss the Bayesian approach to image reconstruction from interferometric data. The Bayesian approach does not just return a "best estimate" of the image, but allows the characterization of significance of individual features in the image. Bayesian image reconstruction requires an explicit image prior. I will argue that a natural prior to use is the "multiplicity prior" which represents the image in terms of N flux units of strength s . This prior reduces to the widely studied entropy prior in the limit of large N and has several conceptual and practical advantages when the signal-to-noise ratio per pixel is near unity. The reconstructed image (Bayes estimate) is obtained by marginalizing the posterior over the parameters N and s . I will demonstrate the implementation of this Bayesian approach using Gibbs sampling. The analysis of simulated radio interferometry data (including point sources and extended emission) results in both a reconstructed image as well as an error model of the uncertainty in the image in terms of the variance per pixel, or significance of individual features. The Bayesian approach produces demonstrably better results than standard library routines. While the Bayesian approach is computationally demanding, recent advances in algorithms, the use of Monte Carlo techniques, and faster computer hardware now allow the exploration of the image posterior and bring full Bayesian image analysis within reach. Looking into the future, I will discuss the remaining challenges and new algorithms that may overcome them; the use of multiscale priors; the generalization of this work to polarimetry; and wideband imaging.

References: Wandelt, Larson, and Lakshminarayanan (2004), *Physical Review D* 70, 083511 (2004); Sutton and Wandelt (2005), *Astrophysical Journal*, submitted.

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