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Bayesian Imaging of the Spatio-Spectral X-Ray Sky

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The advent of the next generation of instrumentation in astrophysics and elsewhere poses several challenges due to the high-dimensional signals that vary in space, time and energy. These typically have non-trivial correlation structures and are often a mixture of overlapping signal components that need to be separated. In order to facilitate multi-instrument analysis of correlated signals in general, we are developing the Universal Bayesian Imaging Kit (UBIK), a flexible and modular framework for high-fidelity Bayesian imaging. UBIK is designed to address these challenges through the use of information field theory, which allows the consistent application of Bayesian logic to signal reconstruction, so that uncertainties can be estimated. In particular, we use generative models to encode prior knowledge about the signals of interest in order to exploit spatial and spectral correlations and thereby improve their reconstruction from noisy data and enhance the component separation.
Here, we show the application of UBIK to the Poisson-noise-affected, latest merged Chandra X-ray data on the supernova remnant SN1006, allowing data sets from different observations to be combined. We present a multi-stage approach in which the spatial reconstruction obtained for a single energy range is used to derive an informed starting point for the full spatio-spectral reconstruction in latent space. This provides a high quality visualisation of the complex features of the remnant without the influence of other sources in the field.

Presenter: WESTERKAMP, Margret (Max Planck Institute for Astrophysics; Ludwig-Maximilians-Universität München A)

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