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Separating Interferometric Artifacts from Extremely Bright Sources using Bluebild

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Weak lensing is a statistical study of galaxy shapes that is an excellent probe of the abundance and growth of cosmic structure. However, the radio weak lensing signal has only once been detected in auto-correlation in the radio regime and has since been detected only in cross-correlation with the optical/IR weak lensing signal. While there have been various approaches towards trying to detect the radio weak lensing signal in auto-correlation, multiple technical problems have made this task extremely difficult.

One of these is the presence of extremely bright, or high signal-to-noise ratio (SNR), sources in the same field of view as weaker, but detectable SNR sources. Having a high dynamic range of sources in an interferometric image tends to add artefacts to the image that make measurement of the shape signal of weaker sources impossible. Extensive peeling, or subtraction of the calibrated high SNR source in visibility space, is typically done to combat this problem. However, this does not always remove all of the artefacts associated with the high SNR source.

We propose the use of the bluebild algorithm as an alternate solution to this issue. Bluebild is an interferometric imager that has been developed to reconstruct the sky intensity matrix directly on the celestial sphere. It uses functional principal component analysis based on the intensity of sources to separate input visibilities into eigen-visibilities. These eigen-visibilities are then reconstructed into eigenimages. Since the PCA is done on the visibilities directly, all reconstructed images contain artefacts only from the sources present within the images. We use this principle to image a model field using bluebild. The field consists of an extremely high SNR source alongside other detectable sources. We use the model as an input to the Oxford SKA Radio Telescope Simulator to produce simulated visibilities and subsequently image this output using the bluebild algorithm. We then evaluate the weak lensing signal extracted from the bluebild output.