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Search and detection of low frequency radio transients

Spreeuw, J.N.

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CHAPTER 8

Epilogue

The source extraction (SE) software is complete and its components have been validated, at least in the case of artificial sources inserted in maps with correlated noise. The software is fast and efficient, well documented and transparent. It is ready for use in the TKP pipeline for the processing of sources in real time. However, if time permits, it is advisable to run tests on dirty and cleaned maps with some sources inserted in the visibilities. Also, it would be good to run it on a series of maps such as the WENSS or NVSS images and compare its output with the contents of the WENSS and NVSS catalogues. In any case, when this software is run on actual LOFAR maps, it is very likely that some adjustments of the code could improve its performance. For example, if the code is run on confusion limited maps, the background level is overestimated. Hence, the fluxes are underestimated. It may be that a more advanced asymmetric clipping algorithm, will reduce a large part of the bias in those cases.

The False Discovery Rate (FDR) algorithm is an essential part of the SE process, because it controls the rate of false alerts. However, it assumes Gaussian statistics for the background noise. Some output of the validation runs indicate that, even in the case when the noise in the visibilities is strictly Gaussian, the noise in the image plane is not. The origin of this is that we are not dealing with a true Fourier Transform, but with either a "Direct Fourier Transform"¹ or with a Fast Fourier Transform (FFT). The result of this is that the number of noise outliers above some high threshold level, say 7σ , is much higher than Gaussian statistics would predict. Peter Jonker suggested to me that the FDR algorithm could be improved by fitting some distribution to the histogram of the noise pixel values. The FDR algorithm could then take account of deviations from Gaussianity. This is an interesting proposition.

With regard to understanding the nature of the enigmatic radio source GCRT J1745-3009, we need either more detections of this source or discoveries of similar systems. In both

¹Called DFT by radio astronomers. Other scientists use DFT for "Discrete Fourier Transform", an invertible operation on regularly spaced data.

cases, many hours of observing time are probably necessary. With LOFAR it remains to be investigated to what extent observations at low elevations, which is entailed when monitoring the Galactic Center from these latitudes, can be properly calibrated. Chances are high that LOFAR will find similar sources at higher Galactic latitudes, which will provide us with the clues we are looking for. A WSRT-LFFE observation of GCRT J1745-3009 on 2009 June 23 remains to be reduced.

With regard to the WSRT observations of SGR 1806-20 in 2005 January, Ger De Bruyn suggested that the error bars on the polarization angles could be improved by using the special RM synthesis software package. This year, LOFAR will start monitoring a large part of the low frequency radio sky and can track the evolution of radio nebulas from the beginning when explosions similar to the Giant Flare from SGR 1806-20 occur. Continuous observing at different LOFAR frequencies will enable us to differentiate between different models for the nebula, since all four polarization products are always recorded. Probably these observations have to be supplemented by observations at higher frequencies by other radio telescopes in order to probe different substructures.

LOFAR observations will also test our models for the radio emission of extrasolar planets. If we are able to detect bursts with LOFAR from many more exoplanets than we predicted, we will have to reconsider our assumptions. Likewise, if we detect none at all, this will also lead to adjustments for the modeling of radiation mechanisms in these systems. It will take a while before we are able to draw some firm conclusions because the search for these bursts takes a considerable amount of observing time.