Part 2 - Scientific abstract

Future generation radio telescopes including SKA, LOFAR and similar instruments will consist of tens of thousands of receiving elements that will be electronically and digitally combined to generate images of the universe at radio frequencies. The organizational of these arrays is hierarchical, where the array consists of stations, each with receiving area of approximately 5,000 square meters. The increasing use of the electromagnetic spectrum as well as the need to obtain much higher sensitivity and/or operate at lower frequencies makes interference from other sources as well as instrument calibration the limiting factor of these instruments. The PI of this research developed a matrix formalism that enables to extend existing imaging algorithms into interference limited environments in conjunction with new parametric imaging techniques. These also open the way to non-Fourier based imaging techniques, with better spatial resolution and improved interference immunity.

The research has three main objectives:
The first objective of this research is to develop new image formation and calibration algorithms, capable of imaging in the presence of both terrestrial interference, as well as interference from stronger astronomical radio sources. The second objective is to develop efficient multi-channel signal processing techniques for interference mitigation at the station level, which are capable of handling efficiently station the huge amounts of data generated by instruments like SKA and LOFAR. The third objective is to test these new techniques experimentally on existing data sets, to verify their validity and applicability for radio astronomical imaging.

We expect that the parametric imaging techniques will lead to better immunity to interference as well as to enhanced spatial resolution. The signal processing techniques developed will also contribute to the efficient implementation of robust beamforming techniques at the SKA station level. We also foresee that the research can contribute to space VLBI, where resolution cannot be further increased by adding more elements. The parametric techniques proposed will be able to enhance the spatial resolution of space VLBI by a factor of 3-5.