Synthesis Imaging in Radio Astronomy: Imaging in the presence of direction dependent effects

S. Bhatnagar,
National Radio Astronomy Observatory, USA

Abstract:

Interferometric radio telescopes use the technique of aperture synthesis to achieve high precision astronomical imaging. Synthesis telescopes are indirect imaging devices where the signals from a number of independent antennas are digitally combined together and recorded for further processing. The data is corrupted due to a number of instrumental and atmospheric/ionospheric effects and represents an incomplete sampling in the Fourier domain. These corruptions are in general also directionally dependent. High dynamic range imaging therefore requires calibration for these direction dependent effects and image reconstruction to remove the effects of incomplete sampling for the Fourier plane. Modern radio telescopes also generate vast amounts of data making run-time efficiency of the algorithms for astronomical imaging and calibration an important requirement.

In this talk, I will briefly describe the general mathematical framework for imaging and calibration in radio astronomy to motivate why it is fundamentally more difficult to design efficient algorithms to make high dynamic range astronomical images fully corrected for the effects of direction dependent corruptions. I will then discuss in more detail, recent advances in the development of optimal high-performance algorithms to correct for direction dependent effects and their relation to image reconstruction algorithms. Some results from the application of these techniques to real data will also be presented.