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Validation of the Matrix Pencil Method based DoA algorithm using tripole antenna for SEAMS

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The radio frequency band ranging from 100kHz to 16 MHz is among the last unexplored Electromagnetic (EM) spectra by radio astronomers. It is challenging to detect frequencies below 16 MHz due to Earth's Ionosphere blocking these frequencies [1]. Studying the frequency bands below 16 MHz will help to understand the magnetospheric emissions from exoplanets and planets, as well as signals from the early universe. To explore the universe in the below 16 MHz band, a space-based radio telescope can overcome the challenge phased by astronomers due to ionospheric blocking and attenuation. Thus, a key area of research in radio astronomical instrumentation has been the study of space-based antenna and radio telescopes [1].

An understanding of a radio source requires knowledge of its direction. Astronomers use triangulation methods or the direction of arrival (DoA) algorithms like MUSIC or ESPRIT to detect the direction of EM waves [3, 4]. Multiple telescope arrangements are required for the aforementioned techniques and methods. In order to employ such techniques an array of space-based radio telescopes can deployed to perform interferometry. However, development of space-based radio interferometers is an expensive and an engineering challenge. This constraints lead to development of DoA techniques and algorithms which can be performed with a single satellite or space-based telescope with a limited number of co-located antennas. Such DoA techniques extensively depends upon the orientation of the antennas on the satellite. In this work describes a DoA technique which is being developed for an Indian origin space project - Space Electric and Magnetic Sensors (SEAMS), designed to probe the 16 MHz and below radio frequency band.

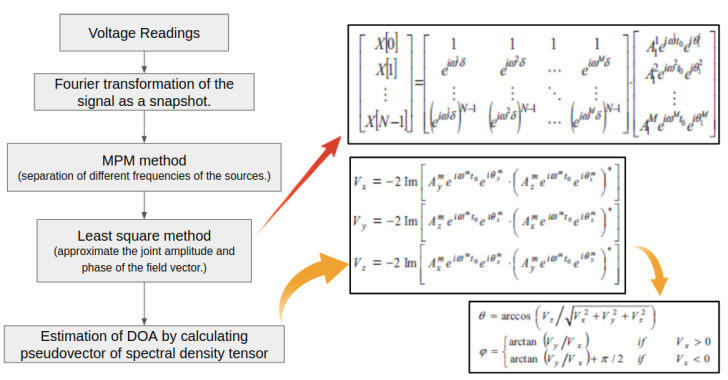

Figure 1. A schematic representation of the DoA estimator

The DoA algorithm in this work is designed for a Tripole antenna (3 orthogonal monopoles). The DoA algorithm utilizes Matrix Pencil Method (MPM) to estimate the incoherent frequency in the spectra and least square method to estimate complex amplitudes along each axis [3, 4]. Finally DoA is estimated by calculating pseudo-vector using the anti-symmetric part of the spectral density tensor which is formed using the estimated complex amplitudes [2].

References

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