

Spatial Array Processing Methods for Radio Astronomical RFI Mitigation

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Over more than a decade there have been a variety of array signal processing methods proposed for interference canceling in radio astronomical observation. Approaches include adaptive filtering, statistically optimal null-steering beamformers, robust adaptive beamforming, vector subspace partitioning, interference tracking algorithms, and use of auxiliary reference antennas. Conventional imaging arrays are obvious candidates where the spatial signature across all antennas may be used to remove interference directly from the visibility/correlation terms. The new wave of phased array feeds under development (e.g. ASKAP, APERTIF, DRAO, BYU/NRAO, Arecibo) also opens up, to both single dish instruments and synthesis arrays, new possibilities for actively nulling interferers independently at each dish. Low frequency aperture arrays (e.g. LOFAR, MWA, LWA, PAPER) have such wide fields of view and operate in such crowded bands that spatial canceling is almost mandatory.

Array signal processing can be used in conjunction with traditional data blanking (or pruning) and frequency avoidance, but if successful the array cancelers will offer the attractive new benefit of continuous operation without data loss in corrupted frequency bands. However, adoption has been very slow. Reasons for delay include 1) costly infrastructure requirements like fast correlator dump times, new digital back end processors, computational burden, array signal transport, and new auxiliary antennas, 2) poor nulling performance for adaptive beamformers, i.e. inability to drive interference 10s of dB below the noise floor, 3) uncertainty about signal of interest distortion while

canceling interference, and 4) lack of a clear science case where critical observations cannot be made without array processing cancellation methods.

This tutorial will present an overview of previously proposed array signal processing RFI mitigation techniques and discuss capabilities and limitations. Newer methods will be presented which achieve significantly deeper nulls and introduce less mainbeam distortion than do typical adaptive beamformers. A “state of the art” review of current practice and discussion of future directions and trends will be presented.

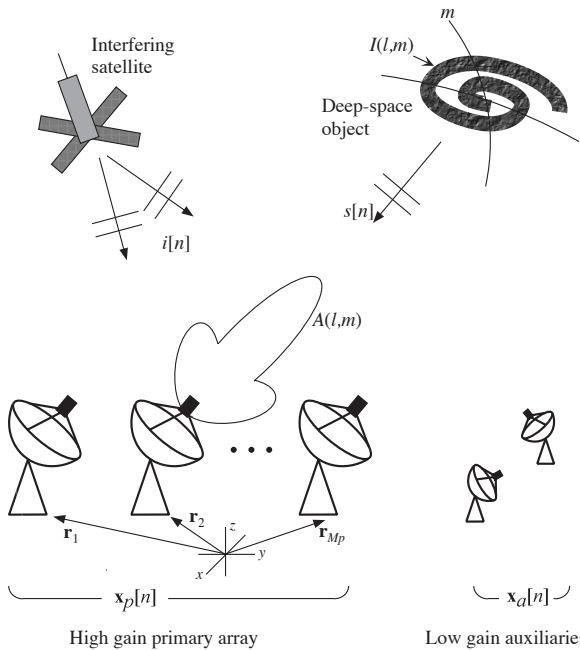


Fig. 1: A satellite RFI scenario at an imaging array with interference tracking auxiliary antennas.