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FINE-TUNING THE NARROWBAND SETI SIGNAL PROCESSING PIPELINE

Abstract

A narrowband radio frequency Search for Extraterrestrial Intelligence (SETI) presumes a long-duration (∼minutes), low bandwidth (∼Hz) beacon or incidental transmitted signal, or technosignature, that would be unlikely to occur in the natural world. A constant-frequency signal at the transmitter will drift in frequency on reception due to relative accelerations between the transmitter and receiver. Drift rates will be proportional to center frequency, e.g. up to ±1 Hz/sec/GHz (Li, Sheikh et al 2023). The typical signal processing pipeline involves creation of spectrograms over a wide bandwidth (up to 1 GHz) with Hz-level frequency resolution, followed by de-Doppler integration, which integrates energy over linearly-drifting tracks in the time-frequency plane.

While search capabilities have greatly expanded over recent years to include interferometric radio telescopes and aperture arrays (MeerKAT, VLA, MWA), commensal observing, and GPU-augmented server racks, the basic signal processing algorithms are largely unchanged. In this talk, updates to the algorithms and their implementation will be discussed. Topics will include:

- An updated de-Doppler algorithm (Houston 2023) and its GPU implementation
- Reducing spectrogram compression to avoid sensitivity losses
- Beamforming implementations
- Use of "stamps", which save complex spectrograms of detections for all antennas over a limited bandwidth
- Post-detection operations in the future, such as direction-of-arrival estimation, radio-frequency interference rejection, and waveform extraction