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SETI 1: SETI Science and Technology (1)

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OPTIMAL OBSERVING STRATEGIES FOR COMMENSAL SETI SURVEYS WITH RADIO TELESCOPE ARRAYS

Abstract

Radio telescope arrays offer exciting possibilities for commensal SETI surveys. Ethernet-based architectural approaches adopted by MeerKAT, the VLA [1] and Allen Telescope Array allow multiple commensal users to receive data simultaneously. Breakthrough Listen is conducting a commensal SETI survey at MeerKAT, subscribing to raw voltage data streams from the F-engines. The Breakthrough Listen system at MeerKAT will perform both coherent and incoherent beamforming on the buffered raw voltages. In the coherent mode, 64 simultaneous beams will be formed on objects of interest within the primary field of view of the telescope. The bulk of the objects for observation will be drawn from a set of 26 million stars drawn from Gaia DR2. A reconfigurable processing pipeline will perform SETI searches on the data from each beam.

Since computing resources are limited, a finite number of beams may be formed and processed simultaneously. Depending on the number of stars in the primary field of view, and the duration of the primary pointing, only a subset of the available stars may be observed. Stars will therefore be ranked according to metrics such as distance, among others. Another question arises in the case of sequences of short-duration primary pointings, when the primary observer is conducting a sky survey for example. Given knowledge of upcoming pointings, should one process all the stars in the current field of view, ignoring subsequent pointings until processing is complete? Or, should stars be processed on a best-effort basis until the next pointing, at which point the current data are discarded in favour of the new? This decision could be guided by a variety of figures of merit (such as the CWTFM [2]) that a SETI survey might optimise for. We analyse the benefits and disadvantages of several approaches and present a program which automatically optimises for a desired figure of merit on the fly.

[1] Hickish, J., Beasley, T., Bower, G., Burke-Spolaor, S., Croft, S., DeBoer, et al., 2019. Commensal, Multi-user Observations with an Ethernet-based Jansky Very Large Array. arXiv preprint arXiv:1907.05263.

[2] Enriquez, J.E., Siemion, A., Foster, G., Gajjar, V., Hellbourg, G., Hickish, et al., 2017. The Breakthrough Listen Search for Intelligent Life: 1.1–1.9 GHz Observations of 692 Nearby Stars. The Astrophysical Journal, 849(2), p.104.