LOFAR as an instrument for SETI: a case study on the Solar Neighborhood
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Even though radio SETI has been ongoing for decades, the constraints on the parameter space which describes the prevalence of intelligence in our galaxy are minimal. From the lack of constraints, it is equally likely that we are the only civilization in the galaxy or that there are thousands of them. If intelligent life is common then nearby stars may show evidence of other civilizations. Even if the radio emission is not intentional, it can come in the form of radio leakage.

Here, I will describe the first SETI experiment done with LOFAR core stations. A volume limited search of artificial signals from nearby stars. We include all stars within 5 pc irrespective of their spectral type. We use the full bandwidth available to LOFAR (10-240 MHz) during this 24 hr observing campaign.

We perform a thorough search of narrow band signals at 1.49 Hz resolution with drift rates up to +/- 10 Hz/s. Since the drift rate is a frequency dependent quantity for a given acceleration, the search range in this work is equivalent to a search of +/- 56 Hz/s at 1.4 GHz for our observations at 250 MHz, this encompasses the rotational and orbital acceleration for any solar-system-like object (terrestrial and gas giant planets, moon, asteroid). For our observations at 20 MHz, the search range is then equivalent to a search of +/- 700 Hz/s at 1.4 GHz, making it the search for the largest range of accelerations ever searched. The more extreme accelerations encompass the largest known orbital acceleration from an exoplanet, as well as the theoretical limits on rotation for both rocky and gas giant planets (Sheikh et al. In prep).

A novel aspect of this search is the use of a multi-beam approach for RFI rejection. From this analysis we were able to reject 89.4% of the signals, by only selecting those having the exact same initial peak frequency, and 99.9987% by allowing a range of frequencies given the measurement uncertainty on the drift rate. The reminder significant events were shown to be false positives after inspection of the data.

LOFAR is an aperture array telescope which allows for great flexibility. The low frequencies allows very wide fields of view. Future SETI experiments could take full advantage of these aspects. New experiments could include the use of the array in Fly’s Eye mode to maximize sky coverage. Using the 24 core stations in this way, one can fully cover the sky at frequencies lower than about 18 MHz, and about 100 square degrees at the highest frequency end.