A multi-year analysis of Radio Frequency Interference from a radio quiet location: preparation for a radio astronomy mission to the far side of the Moon

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Description: The CSIRO is the operator of Inyarrimanha Ilgari Bundara, the CSIRO Murchison Radio-astronomy Observatory (hereafter the MRO). The MRO is the location at which an international consortium is building the largest and most sensitive low frequency radio telescope ever conceived, the Square Kilometre Array (SKA).

The SKA is being built at the MRO because of the extreme radio quiet status of the site, due to its remote nature and low population density. The preservation of the radio quiet environment of the MRO is fundamental to the effective operation of the SKA, and SKA precursor telescopes currently in operation at the site.

As such, an important function undertaken by the CSIRO is the continuous monitoring of the Radio Frequency Interference (RFI) present in the MRO environment. RFI is radiation produced by human activities and can include terrestrial radio communications (private and commercial), transmitters based on satellites, radar systems, transmissions to support air traffic, and the incidental radiation caused by all manner of electronic devices that infuse most modern human activity.

The CSIRO has collected extensive RFI monitoring data at the MRO since 2016, accumulating 16 TB of data across the frequency range 20 to 3000 MHz with a sweep time of 1.49s and 100 kHz resolution, along with an additional 4 TB of data at 62s sweep time at 3.125 kHz resolution over the same frequency range. The data include a rich variety of RFI behaviour, across different origins and form a unique resource for the exploration of the origin of RFI and its impact on radio astronomy. Radio astronomy relies on radio quiet conditions in order to perform observations that reach back to the origin of the Universe, allowing astronomers to study the structure and evolution of the Universe.

The ultimate radio quiet location in the Solar System is on the far side of the Earth's Moon. The Moon is tidally locked to the rotation of the Earth, so that from the Earth we can only ever see one half of the Moon's surface. Conversely, the half that we cannot see (the far side) can never see the Earth. Therefore, all of the RFI generated on the Earth is blocked by the Moon, for locations on the Moon's far side.

The Breakthrough Foundation is contemplating missions to the far side of the Moon, to exploit this ultimate radio quiet environment to perform radio astronomy.

This PhD project will utilise the multi-year MRO RFI dataset to extract information and intelligence on the origin of the RFI and its impact on radio astronomy. This will be a pathfinding and preparatory exercise for an analogous exercise on the far side of the Moon, in terms of designing an RFI monitoring system for the far side, to support radio astronomy from that location. Of particular interest will be the characterisation of weak and/or intermittent RFI, as the expectation of the far side is that the levels of RFI will be very low, if indeed detectable at all.

The PhD student will analyse the MRO RFI data, interpret the results in terms of the origin of the RFI, estimate the expected impact of the RFI on radio astronomy, and assist in informing the design of an RFI monitoring system that could be used for a mission to the far side of the Moon.