''COGITO in Space": a thought experiment in exo-neurobiology

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Abstract

In 2014, media artist Daniela de Paulis first presented at ASTRON in The Netherlands the possibility of radio-transmission of brain activity as part of her project ''COGITO in Space", for which laboratory-grade EEG recordings are analyzed and converted to sound in real-time, using an open-source interstellar EEG-transmission protocol designed for the project by Guillaume Dumas and Michael Sanders and integrated in the EEGsynth fieldtrip software package. The 25m dish antenna of the Dwingeloo radio telescope in The Netherlands instantly transmits this audio-stream into space while the participant's brain activity is recorded. The antenna uses amateur radio equipment, with a SingleSideBand (SSB) 120W power transmission with a fixed dish position. By spreading transmissions over the sky chances of possible detection by an alien civilization are limited. One of the challenges of the project was the real-time conversion of 32-channel EEG into a mono 3kHz audio signal for a linear SSB modulated radio transmission, including the 3D electrode positions that would allow the reconstruction of the cortical activity and topography by a hypothetical receiver.

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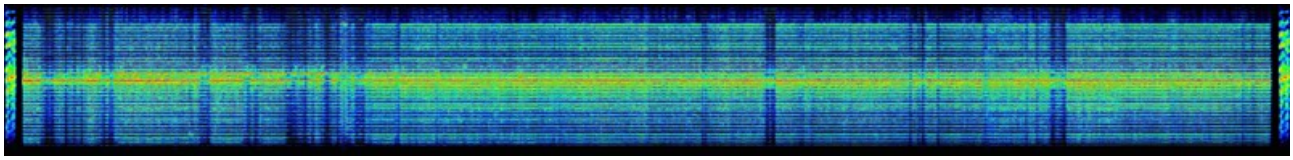
In 2014, media artist Daniela de Paulis first presented at ASTRON in The Netherlands the possibility of radio-transmission of brain activity as part of her project ‘'COGITO in Space'', for which laboratory-grade EEG recordings are analyzed and converted to sound in real-time, using an open-source interstellar EEG-transmission protocol designed for the project by Guillaume Dumas and Michael Sanders and integrated in the EEGsynth fieldtrip software package. The 25m dish antenna of the Dwingeloo radio telescope in The Netherlands instantly transmits this audio-stream into space while the participant’s brain activity is recorded. The antenna uses amateur radio equipment, with a SingleSideBand (SSB) 120W power transmission with a fixed dish position. By spreading transmissions over the sky chances of possible detection by an alien civilization are limited. One of the challenges of the project was the real-time conversion of 32-channel EEG into a mono 3kHz audio signal for a linear SSB modulated radio transmission, including the 3D electrode positions that would allow the reconstruction of the cortical activity and topography by a hypothetical receiver.

The interstellar EEG-transmission protocol converts the EEG into a single audio channel as follows: first all the 32 channels of EEG are converted into the frequency domain. Since most human EEG signals obtained in frequencies are under 45Hz (higher frequencies are dampened by electrical resistance of the skull and skin), only this frequency-range was retained. All the 32 channels are subsequently concatenated in the frequency domain using complex matrix multiplication, with each channel encoded into a 75Hz bandwidth. Each 75Hz part starts with a pure (identifier) tone at 1Hz, followed by the 1-45Hz spectrum of the EEG channel. The X, Y and Z-positions of the electrode are then encoded through frequencies of additional tones in three successive 10 Hz bands. The frequency representation is then converted back to a single audio channel with bandwidth of 2.4kHz. This process occurs in real-time with fixed time (ca.1 second) fieldtripbuffer data slots and a minimal time-lag between recorded EEG and live transmitted radio signal. The conversion includes a 300Hz shift and a non-linear transformation of the spectrum for compensating the filter effect of the hardware of the radio-equipment within the 0.3-3 kHz frequency limit.

For the project a brain activity recording was reflected off the surface of the Moon (Moon bounced) using the Dwingeloo radio telescope in order to test the possible retention of the signal in interstellar space. After the test, despite the considerable loss of signal plus distortion of data, the message could still be retrieved and interpreted as a bio-signal. This proved the communication potential of EEG signals, distorted and dispersed over a distance equivalent of at least 2.6 billion kilometers, using two 'telescopes- radio antennas identical to the ones used in the "COGITO in Space". Interstellar communication using neurological signals could be possible, however one should use arrays of big dish antennas with synchronized ultrahigh power transmitters to cover multiple lightyears of distance.

"COGITO in Space" provides an interesting input on the possible search and detection of techno-signatures that might contain direct biological and/or physiological data recording from an advanced civilization.



Spectrogram of the brain activity recording in "COGITO in Space" by Michael Sanders