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The Netherlands - China Low Frequency Explorer

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Extended Abstract

Low-frequency radio astronomy in the frequency band below about 30 MHz can only be done well from space due to the Earth's ionosphere cut-off and man-made radio frequency interference (RFI) that make sensitive measurement from ground-based facilities difficult or impossible.

In 2016 a partnership agreement was established between the Netherlands Space Office (NSO) and the Chinese National Space Administration (CNSA). Following this, a team from ASTRON, Radboud University (PI), and ISIS, in close collaboration with NAOC, started developing a low-frequency scientific receiver, the Netherlands-China Low-Frequency Explorer (NCLE). The NCLE receiver will be mounted on the Chang'e 4 relay satellite, and is expected to be launched in 2018. The relay satellite will orbit the Earth - Moon L2 point, at roughly 64000 km behind the Moon.

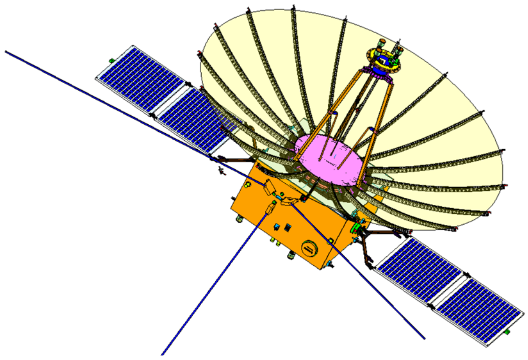

Figure 1 Drawing of the Chang'e 4 relay satellite with three monopole antennas mounted

NCLE will allow for unique radio science and astronomy [1]. This includes a wide range of science topics, such as constraining the red-shifted 21-cm line Dark Ages and Cosmic Dawn signal, measuring the auroral radio emission from the large planets in our Solar system, determining the radio background spectrum at the Earth-Moon L2 point, studying the Solar activity and space weather at low frequencies, creation of a new low-frequency map of the radio sky, studying the Earth's ionosphere, and the detection of bright pulsars and other radio transient phenomena at very low frequencies. In addition, the access to a previously unexplored frequency regime will undoubtedly lead to new discoveries. NCLE will be a first step towards opening up the virtually unexplored low frequency domain for astronomy.

The NCLE design involves three co-located, 5 m monopole antenna elements mounted on the spacecraft wall, cf. Figure 1. These antennas are configured as dipoles to minimize common mode interference. NCLE will have its optimal sensitivity in the frequency range between 1 and 80 MHz where the highest priority science signals are expected, but will extend down to the kHz regime, albeit with reduced sensitivity. The analogue signals are digitized in a DSP system on which dedicated science modes are implemented in a flexible software-defined radio system. These modes for instance perform fast Fourier transforms to create average radio spectra, allow triggering on transient radio events, or allow to retrieve direction of arrival information using beam-forming or goniopolarimetry techniques. Raw time traces can be stored for ground-based post processing and VLBI.

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References

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