

## The Netherlands-China Low-frequency explorer (NCLE)

A. Vecchio<sup>\*(1,2)</sup>, M. Klein-Wolt<sup>(1)</sup>, C. Brinkerink<sup>(1)</sup>, Poushaghaghi<sup>(1)</sup>, S. Karapakula<sup>(1)</sup>, H. Falcke<sup>(1)</sup>, A.J. Boonstra<sup>(3)</sup>, M. Bentum<sup>(4,3)</sup>, M. Ruiters<sup>(3)</sup>, J. Rotteveel<sup>(5)</sup>, E. Bertels<sup>(5)</sup>, J. Ping<sup>(6)</sup>, L. Chen<sup>(6)</sup>

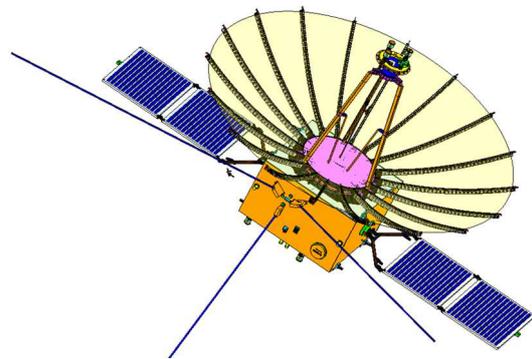
- (1) Radboud Radio Lab, Astrophysics Department Radboud University, PO Box 9010 6500 GL Nijmegen, NL
- (2) LESIA, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université, Univ. Paris Diderot, Sorbonne Paris Cité, 5 place Jules Janssen, 92195 Meudon, FR
- (3) Netherlands Institute for Radio Astronomy (ASTRON), PO Box 2, 7990 AA Dwingeloo, NL
- (4) Eindhoven University of Technology, Faculty of Electrical Engineering, 5600 MB Eindhoven, NL
- (5) ISIS - Innovative Solutions in Space, Motorenweg 23, 2623 CR, Delft, NL
- (6) National Astronomical Observatories (NAOC, CAS), 20A Datun Road, Chaoyang District, Beijing 100012, CN

### Extended Abstract

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, low-frequency radio astronomy in the frequency band below about 30 MHz can only be done well from space.

The Netherlands- China Low-Frequency Explorer (NCLE) radio instrument, on the Chinese spacecraft Queqiao, was launched on May 21st, 2018 and orbits the Earth-Moon L2 point at roughly 64000 km behind the Moon. NCLE, the only radio observatory currently behind the Moon, is a unique instrument aiming to detect a wealth of science in the low-frequency radio regime [1]: the pristine and faint signals from the hydrogen in the Cosmological Dark Ages and Cosmic Dawn, the study of Solar activity and space weather at low frequencies, the measure of the auroral radio emission from the large planets in our Solar system, the determination of the radio background spectrum at the Earth-Moon L2 point, the creation of a new low-frequency map of the radio sky, the study of the Earth's ionosphere, and the detection of bright pulsars and other radio transient phenomena at very low frequencies.

The instrument is sensitive in the 80 kHz to 80 MHz regime and is designed to have a number of dedicated science modes with pre-defined bandwidth and spectral resolution. The analogue and digital chains are designed and built by ASTRON and the Radboud Radio Lab (Radboud University), respectively. The NCLE design involves three custom-made design carbon fiber antenna units, each five-meter-long, mounted on the spacecraft wall (Figure 1) which are fully deployable and retractable, produced by the Dutch Industry Partner ISISpace (Delft).



**Figure 1.** Drawing of the Chang'e 4 relay satellite with the three monopole antennas in the foreground.

Currently NCLE antennas have been partially deployed and the instrument is in the commissioning phase and on-ground calibration activities have started.

### References

- [1] S. Jester and H. Falcke. "Science with a lunar low-frequency array: from the dark ages of the universe to nearby exoplanets," *New Astronomy Reviews*, **53**, February 2009, pp. 1-26, doi: 10.1016/j.newar.2009.02.001