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LARAF: a radio array on the lunar farside concept

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The far side of the Moon provides ideal sites for the observation of radio sky at the decameter and hectometer wavebands (below refered to as the ultralong waveband), for which ground-based observation is hampered by the ionosphere and radio frequency interference (RFI). Here we present a concept of an ultralong waveband radio array on the far side of the Moon. Compared with lunar orbit array such as the DSL[1], the lunar surface offers a stable platform, which is important for building up larger array and achieving higher sensitivity.

The ultimate goal of the far side array is to observe the primordial fluctuations during the cosmic dark ages, which contains huge amount of precious information about the cosmic origin. However, such observation would require extremely large array of antennas to achieve the required sensitivity. An array with a few hundred antennas would be a significant step towards that goal, while its main scientific objective is to survey the ultralong waveband sky with good sensitivity. Such observations would reveal the sky at an heretofore unexplored part of the electromagnetic spectrum, and would likely produce precious information about many astrophysical process, such as supernova remnants, acceleration and propagation of cosmic rays, flare of stars, magnetosphere of exoplanets, distribution of interstellar medium, and the production and evolution of radio jets from the supermassive blackholes, and of course the radio activity of our own Sun and solar system planets.

Based on the current technology and engineering capability, including various options for the power supply, data communication, deployment, and position determination, a concept of an array on the lunar farside called LARAF has been proposed [2]. At the center is a master station, and a lunar rover will deploy about 20 substations in a flat region about 10km size around it, connected by optical and power cable. Each substation has 12 antennas, printed on long and thin membrane[3], and the signal is amplified and transmitted to the master station by the optical fiber. The array will make interferometric observation during the lunar night, while charging during the lunar day.

The continous observation of such an array on the lunar far side would build up our knowledge about the ultralong wavelength astronomy, and prepare for the deeper observation required for the study of primordial fluctuations.

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[2] Xuelei Chen, Feng Gao, Fengquan Wu, Yechi Zhang, Tong Wang, Weilin Liu, Dali Zou, Furen Deng, Yang Gong, Kai He, Jixia Li, Shijie Sun, Nanben Suo, Yougang Wang, Pengju Wu, Jiaqin Xu, Yidong Xu, Bin Yue, Cong Zhang, Jia Zhou, Minquan Zhou, Chenguang Zhu, Jiacong Zhu, 2024, "Large-scale Array for Radio Astronomy on the Farside", Philosophical Transactions of the Royal Society A.382,20230094, https://doi.org/10.1098/rsta.2023.0094; arxiv:2403.16409

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