LOW FREQUENCY OBSERVATION ON THE MOON

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Abstract

We propose a future project on astronomical radio observation on the lunar far side at very low frequencies ($\sim$ 100kHz to $\sim$ 30MHz). It is the last frequency range for the radio astronomy, and high accuracy observations in this frequency range are yet to be realised. This is mainly because the ionosphere prevents us from observing the radio waves below the ionospheric cutoff frequency on the ground, and that the high resolution is difficult to be achieved since the angular resolution is proportional to the wavelength of radio waves. And, even in the earth's orbit, because of the solar burst, man-made noises and auroral emissions from the Earth, observation of the faint radio waves from planets and celestial objects is difficult. The lunar far-side is a suitable site for the low frequency astronomical observations, because noises from the Earth can always be avoided and radio waves from the Sun can be shielded during the lunar night. In periods of Jupiter's conjunction with the Sun, the strong emissions from Jupiter can be also avoided to observe fainter signals.

Assuming that the Japanese lunar exploration program will be conducted as continuous series, we have been discussing the feasibility to realize a low frequency array on the lunar far-side step by step. An Earth-Moon baseline interferometer at 30 MHz is positioned as the first step, which is used for the elucidation of the fine structure of the Jovian decameter wave. Fundamental measurements of the lunar surface environment will be also proposed in this stage. They will provide the basic information on the surface temperature, dust properties and the permeability for the further step. At the second step, an array on the lunar near side is considered for the acquisition of array technique on the Moon. At the third step, an array is put on the far-side for the full astronomical observation.

At the first step, one set of antenna would be placed on the lunar near-side to observe radio emissions from Jupiter with high resolution (about 15 km on the Jupiter). This experiment will be also a demonstration of the landing technology onto the Moon and deploying the antenna, communication with the mother ship or ground stations on the Earth, and survival at long and cold nights which last 14 earth-days with as cold as 120 K.

As of 2005, we assume the following way of deploying an antenna on the Moon. A set of cross dipole antenna of 5m tip-to-tip is attached to a torus-shaped inflatable,

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which is inflated after landing so that the antenna can be elongated. The cold-setting complex materials are put in it, which become hard once they are exposed to the lunar night so that it can sustain the structure. However, this inflatable with diameter of 5 m becomes as heavy as 40 kg and it is difficult to be delivered to the Moon in a small mission. Therefore the use of the simple stem antennas is also under consideration. Because the lunar gravity is one sixth of the Earth, the deflection of the antenna is considered to be smaller than that on the Earth.

A cross dipole antenna has its maximum sensitivity in the normal direction to the plane which is made with antennas, the antenna should be put at low latitudes or equatorial regions for the observation of the solar system objects. In this case, the antenna system should survive long nights. In terms of the temperature condition and the power supply, peaks of eternal light at polar regions, if they exist, are preferable because instruments are always sunlit there. In this case, the antenna should have the sensitivity in the horizontal direction. We need more study to select appropriate shape of antenna and landing site.