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Properties of monochromatic whistler waves near the Moon detected by Kaguya

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We study monochromatic whistler waves near the Moon observed by LMAG aboard the Kaguya spacecraft. The waves were mostly left-hand polarized in the spacecraft frame and observed as narrowband magnetic fluctuations with frequencies close to 1 Hz. Although the monochromatic whistler waves near the Moon were also observed by Lunar Prospector [Halekas et al., 2006], the spectral formation mechanism and the generation process of the waves have not been fully understood.

In the present study, we perform statistical analyses to reveal the properties of the monochromatic whistler waves near the Moon. The results indicate that the intense waves are generated by the solar wind interaction with lunar magnetic anomalies. High occurrence rates of the waves are found in the range of the solar zenith angle (SZA) from 40 to 90 degrees with remarkable north-south and dawn-dusk asymmetries in the SSE coordinate. Similar asymmetries are found in the selenographical distributions as well. We explain these asymmetries by the localization of magnetic anomalies and the effects of SZA dependencies. Plasma wave theory predicts that the occurrence, intensity, and frequency of the waves are determined by the wave vector direction, magnetic field direction, and solar wind parameters. From the investigation of these parameter spaces we reveal that the properties of the waves can be explained by the Doppler shifted whistler-mode waves propagating against the solar wind.

Moreover, based on the results of the statistical analyses, we compare the properties of the observed waves quantitatively with those of upstream whistler waves from planetary bow shocks reported in previous studies. While we find different properties possibly caused by the differences of the distance from the source region, we discuss the similarities among them suggesting important clues in understanding the generation process of the monochromatic whistler waves near the Moon.

Keywords: whistler-mode, narrowband, magnetic anomaly, reflected ion