

Group-standing effects on upstream whistlers around the Moon and planetary bow shocks

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The solar wind interacts with the solar system bodies in various manners depending on the size and state of the body. It is notable that upstream whistlers have been commonly observed in the upstream regions of many solar system bodies, whereas their sizes and states are different. A wide variety of energy sources of the waves have been proposed including reflected ions and electrons from the bow shock, temperature anisotropies in the foreshock, and shock front perturbations. In order to clarify the generation process of the waves, it is necessary to understand effects on the observed wave spectra.

We propose the group-standing effects [Tsugawa *et al.*, 2014] which can form the observed wave spectra: narrowband wave spectra with frequencies near 1 Hz. The group-standing condition can explain dependences of the wave frequency and wave vector direction observed by Kaguya around the Moon and by Geotail around the terrestrial bow shock. Since the wave properties of the narrowband upstream whistlers are mostly determined by the group-standing effects, it is difficult to clarify the generation process of the narrowband waves from the observed properties. We find the same source waves while they are not group-standing, which are observed as right-hand polarized broadband waves in the frequency range around the lower hybrid frequency with their wave vectors mainly parallel to the magnetic field. The distributions of their frequencies and wave vector directions are possibly determined by the generation process, such as resonance with ion beams and electron temperature anisotropies.

Reference

Tsugawa, Y., Y. Katoh, N. Terada, T. Ono, H. Tsunakawa, F. Takahashi, H. Shibuya, H. Shimizu, and M. Matsushima (2014), Group-standing of whistler-mode waves near the Moon, *J. Geophys. Res. Space Physics*, in press, doi: 10.1002/2013JA019585.