MESSENGER Observation of Standing Whistler Waves Upstream Mercury's Bow Shock

Yang.Wang[1],Jun.Zhong[1]

[1]Key Laboratory of Earth and Planetary Physics, Institute of Geology and Geophysics, Chinese

Academy of Sciences, Beijing, China

e-mail (speaker): wangyang19@mail.iggcas.ac.cn

Whistler waves are common feature upstream of the planetary bow shocks. These waves may be generated by shock, or shock may be formed by steepening of these waves. There are two types of whistler waves that emit from shock ramps, the propagating whistler wave and the phase standing whistler wave. [1] he phase standing whistler wave, occurred upstream of subcritical shocks during low M_A, characterized by the propagation along the normal of the shock with a constant phase respect to the shock ramp and the rapid damping. The wave polarization is right-handed in relation to the average field direction when the observer moves from the upstream to downstream but is left-handed when the observer moves in the opposite sense. [2,3,4]

Here we report the first observations of standing whistler waves upstream of Mercury's quasi-perpendicular bow shock.Figure 1 is a pair examples. With the MESSENGER Magnetometer data, a total of 36 wave events were identified during the interplanetary coronal mass ejections (ICMEs) .These waves with elliptic or circular polarization are characterized by (1) a constant phase with respect to the shock ramp, (2) propagating along the normal of shock, and (3) rapidly damping with a few times wavelength. (4)upstream Alfven mach number(M_A) is low. We infer the speed of Mercury's bow shock that is ~34 km/s and width of shock is $1.93 c/\omega_{pi}$. These events existed 20% of orbits during ICMEs. We suggest that Mercury's bow shock is key natural laborary for the forthcoming Bepi-C to comprehensive understanding of the standing whistler waves upstream collisionless shock at low M_A solar wind in the inner heliosphere.

References

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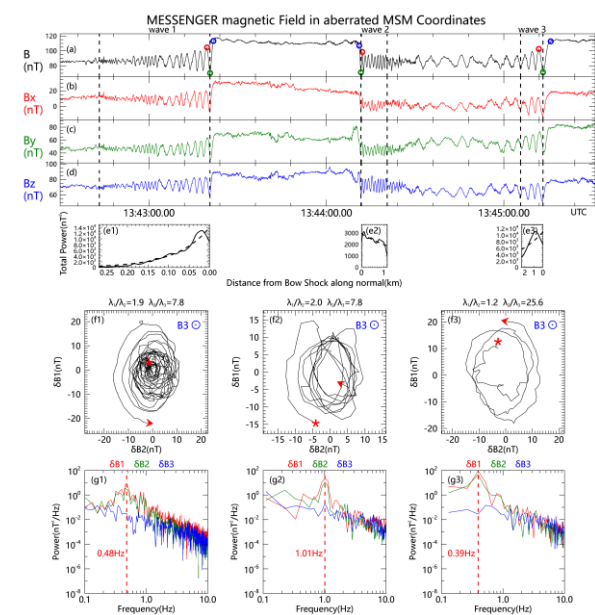
Figure 1.A pair examples of standing whistler waves upstream Mercury's bow shock observed by the MESSENGER (a) Magnetic field strength B of shock crossings during ICMEs in aberrated MSM coordinate system. The red, and green/blue dots in Figure 1a are corresponding to the peak of wave and start/end of the shock ramp. (b)Bx in aberrated MSM coordinate system (c) By in aberrated MSM coordinate system (d) Bz in aberrated MSM coordinate system(e)The total power as fuction of distance from the bow shock along normal . (f) The magnetic field data of the wave in the maximum-intermediate plane in MVA after removing background magnetic field. (g) The power spectral density in MVA after removing background magnetic field.