8th Asia-Pacific Conference on Plasma Physics, 3-8 Nov, 2024 at Malacca

MMS Observation of Collisional effects on Whistler instability in a kappa distributed anisotropic magnetized plasma in a Magnetic Hole

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Numerous researchers have investigated whistler waves in various regions of the Earth's magnetosphere and in the solar wind using multiple approaches. Motivated by the reported literature, in this paper, we investigate whistler waves observed by the Magnetospheric Multiscale Mission at the boundary of the magnetic hole in the solar wind. First, an analytical expression for growth rate of whistler instability has been derived for varying values of spectral index κ, collision frequency νei, temperature anisotropy δ and ambient magnetic field Bo. A comparison between Maxwellian and kappa distribution functions shows a higher growth rate in the case of Maxwellian particles. The growth rate tends to decrease with an increase in collisions of suprathermal particles. Based on local plasma parameters, the growth rate of whistler instability over a frequency range is found to be consistent with the observed from the mission.

The collisional frequency increases by increase in the value of spectral index κ and therefore resulted in damping of the whistler instability. This damping is however maximum for the particles obeying Maxwellian distribution. Increase in collisional frequency causes an increase in suprathermal particles and instability even exists in the presence of highly energetic particles representing less damping. Due to small value of temperature anisotropy, the growth rate curves started intersecting each other at larger values of k.

The data set from the MMS mission provides ample evidence of the existence of whistler waves in the MH in the solar wind. Besides the solar wind, various authors have reported whistler waves associated with MH in various regions of the Earth's magnetosphere. In the present study, we chose one MH from the solar wind detected by all four satellites at the same time. We investigated the various characteristics of the wave emissions found at the boundary of MH.

Based on the observed properties, we can conclude that this sort of wave emission is a whistler. Furthermore, we used a theoretical model in order to verify the existence of whistler waves near the MH's boundary.

References

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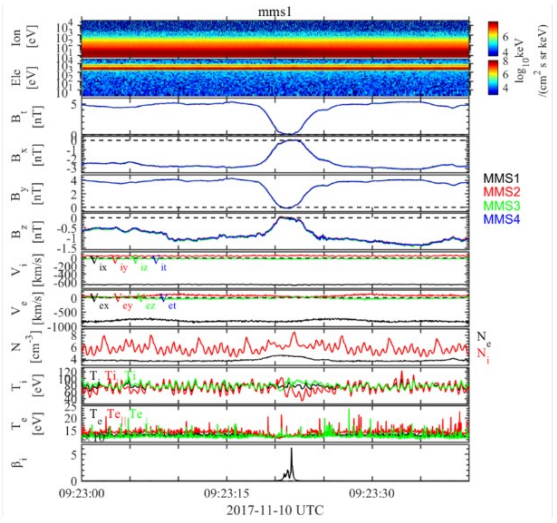

Figure 3: Overview of the MMS satellites observation. Here, all parameters are plotted in the GSE coordinate system.