URSI AP-RASC 2019, New Delhi, India, 09 - 15 March 2019

Electromagnetic Ion Cyclotron Waves in Lunar Wake: ARTEMIS observation

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Earth's natural satellite moon does not have an intrinsic magnetic field and thus the magnetic field measured at moon by various spacecraft is of the solar wind origin. There are few strong magnetic field regions at the lunar surface and drastic decrease in magnetic field is observed in the downstream within few kilometers (~30 Km) away from the lunar surface. The moon act as the obstacle for the solar wind flow and in the anti-sun direction arise a cavity, called 'Lunar Wake'. Several studies have shown the plasma diffusion process in the wake region. Due to higher thermal velocity of the electrons than the ions, charge separation take place and plasma quasi-neutrality condition violated. This situation is tackled by set up of ambipolar electric field, which causes retardation of electrons and acceleration of ions and the diffusion of both electrons and ions become comparable, refilling of wake happens. Though, in the wake region mostly electrostatic waves such as ion acoustic and some whistler waves have been observed, we investigate the presence for electromagnetic ion cyclotron wave activities in the wake region. Here we present an observation by ARTEMIS B and ARTEMIS C, where at the same time in the perpendicular magnetic field component electromagnetic wave activity is observed. We further analyzed the wave propagation properties like wave normal angle, ellipticity, polarization etc. It is found that the waves have propagation angle almost lower than 35^0 and the wave activity is below the proton gyro-frequency ($\Omega_H +$), these helped us to speculate those are Electromagnetic Ion Cyclotron (EMIC) Waves. These waves (frequency range of Pc1 & Pc2 i.e. 0.1 to 5 Hz) are well established in the Earth's magnetosphere and play major role for the pitch angle scattering of the relativistic particles from ring current. Acceleration and loss mechanism of the charged particles occurs due to mainly by EMIC waves, hence the magnetospheric dynamics is strongly affected by EMIC waves. In the lunar wake MeV range particles are present from the solar wind source. We obtain the cross-correlation between the different magnetic components of the wave magnetic field. These intense waves are almost observed simultaneously by ARTEMIS B & C, hence spatial broadening of EMIC waves is also studied. Thus our study will help to build up the importance of EMIC waves for the dynamics of lunar wake.