URSI AP-RASC, Sydney, Australia, 17-22 August 2025

Wave-Driven Energetic Electron Flux at the Earth's Magnetopause

Shubhangi Lagad*(1), Amar Kakad (1), and Bharati Kakad(1)
(1) Indian Institute of Geomagnetism, New Panvel (W), Navi Mumbai, 410218,
e-mail: shubhangilagad1@gmail.com

The interaction between the solar wind and geomagnetic field drives complex plasma processes in the magnetosphere across various spatiotemporal scales. The magnetopause which is the boundary between the varying solar wind and comparatively stagnant magnetosphere mediates this interaction. The solar wind varies on the timescales less than seconds to hours triggering various plasma instabilities which are unstable to plasma waves at ion and electron scales. In the collisionless magnetospheric plasma, these waves will play a crucial role in the energy transfer between electromagnetic fields and different particle populations. The high-frequency plasma waves can grow rapidly compared to other temporal scales and thus play a significant role in wave-particle interactions. Understanding such small-scale processes is crucial to get insights into the near-Earth space weather.

In this context, we present the first observation of prolonged electron flux enhancement reaching very high energy up to 650 keV at magnetopause near the subsolar point, notably without reconnection signatures. The observation reveals that this high-energy electron flux enhancement is associated with the simultaneous occurrence of electron cyclotron wave harmonics, whistler waves, and Langmuir waves. Theoretical modeling confirms the wave generation by electron temperature anisotropy and the electron loss cone distribution. This direct, in-situ observation of high-energy electron flux linked to cascaded wave-particle interactions will help us advance our understanding of the tiniest electron-scale intricacies affecting near-Earth space weather. This study reveals how the background plasma conditions around the magnetopause are often unstable to intense electron-scale wave activity and the role of these waves in plasma dynamics.