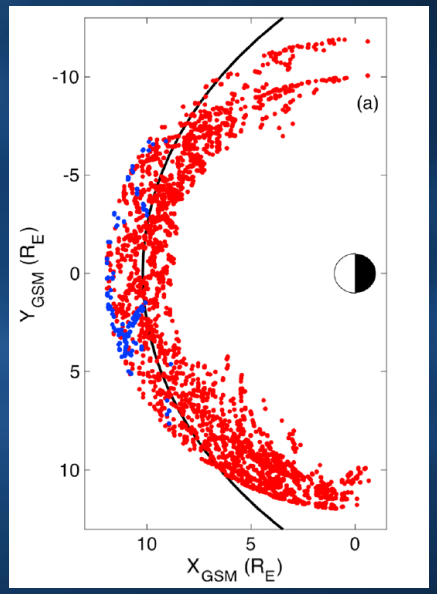
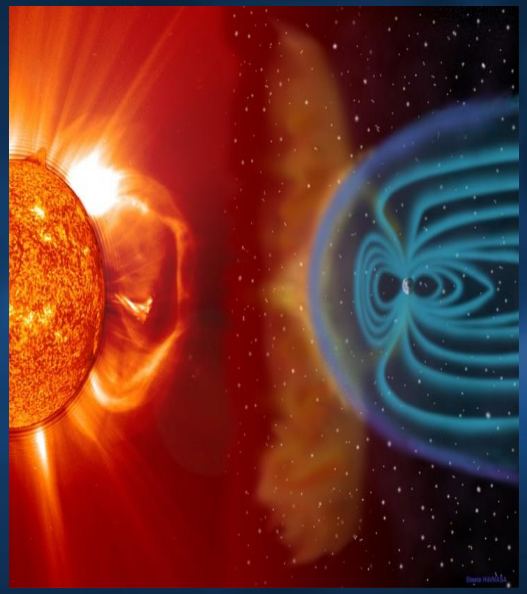
Large-Amplitude Waves at Earth's Magnetopause

Earth's magnetosphere is a vast comet-shaped region of space, which can shield the planet from the constant bombardment of solar wind, the charged particles that stream off the Sun. The magnetosphere is primarily generated by Earth's charged iron core, which extends a magnetic field outwards into space where it meets and interacts with the solar wind. Due to the speed of the solar wind, a bow shock is created in front of Earth, heating the solar wind plasma. Such bow shocks are sites of intense plasma wave activity and contribute to energy exchange between the solar wind and magnetosphere. Among the many plasma waves that are generated in this region, Langmuir and upper hybrid waves are of special interest because they provide a tool to explore how electrons gain energy in this region.

A study recently published in the Journal of Geophysical Research: Space Physics, has identified the distribution of the high amplitude plasma waves near the magnetopause as Langmuir and upper hybrid waves.





Left: Location of wave events at the magnetopause and in the magnetosphere (red) and at the foreshock (blue), in Geocentric Solar Magnetospheric coordinates.
Right: A visualization of the magnetosphere and solar wind interacting.

Langmuir waves are oscillations in electrons and the electric field that are parallel to the magnetic field; upper hybrid waves oscillate perpendicular to the magnetic field. Looking at data from the first two phases of the Magnetospheric Multiscale (MMS) mission, the research found that these waves are located all along the magnetopause, though the upper-hybrid waves are more common in the magnetosphere and along the magnetopause, while the Langmuir waves are more common outside the magnetopause, where the magnetic field is weaker.

Further research will focus on determining how efficient these waves are at generating radio emissions, as well as the source of the observed waves, such as the role magnetic reconnection plays in their generation.

Graham, D. B., Vaivads, A., Khotyaintsev, Y. V., André, M., Le Contel, O., Malaspina, D. M., et al. (2018). Large-amplitude high-frequency waves at Earth's magnetopause. Journal of Geophysical Research: Space Physics, 123.https://doi.org/10.1002/2017JA025034