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Ring-shaped expanding pulsating aurora: simultaneous observations with Arase

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During a coordinated campaign observation of pulsating aurora using the Arase satellite in March 2017, we observed a unique radial expansion of pulsating aurora that eventually formed a concentric ring-shaped structure. This phenomenon, which was captured by an all-sky camera in Sodankylä, Finland, occurred in a 5 min interval from 00:05 to 00:10 UT on March 29, 2017 and began as a small patch of diffuse aurora in a limited region. The initial expansion of this patch was similar to the expansion-type pulsating aurora previously reported in literature (Scourfield and Parsons, 1971). Subsequently, a small dark area appeared in the center of the initial patch and also expanded radially, ultimately resulting in the formation of a ring of diffuse aurora. By tracing the outer and inner boundaries of the expanding structure, we estimated the speed of the radial expansion to be approximately 1000 km/s in both the radial and longitudinal directions.

The magnetic footprint of the Arase satellite was located near the outermost part of the final shape of the ring structure. The PWE/OFA instrument on board the satellite observed collective bursts of chorus, whose intensity variation was similar to that of the pulsating aurora. However, there was a systematic delay in the timing of detection, possibly due to the location of the satellite on the outer part of the expanding structure. This suggests that something was also expanding in the magnetospheric counterpart. We speculate that changes in background plasma parameters, such as cold plasma density or magnetic field intensity, propagated in all directions from a single point on the equatorial plane of the magnetosphere and triggered the chorus waves sequentially. This sequential triggering of chorus at the magnetic equator likely caused corresponding energetic electron precipitation, resulting in the ring-shaped pulsating aurora in the ionosphere. Given the expansion speed of approximately 1000 km/s in the magnetosphere, the fast mode magnetosonic wave is a likely candidate for the propagation of background plasma parameters perpendicular to the magnetic field.

In this presentation, we will detail the spatiotemporal variation of the expanding ring-shaped pulsating aurora through the use of images from a ground-based high-speed camera and discuss the mechanism responsible for this peculiar behavior in relation to the characteristics of magnetospheric waves.

References

[1] Scourfield, M. W. J., and N. R. Parsons. 1971. “Pulsating Auroral Patches Exhibiting Sudden Intensity-Dependent Spatial Expansion.” Journal of Geophysical Research 76 (19): 4518–24.

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