Stagnant Transpolar Arc and Its Intensification during Dual Cusp and Magnetotail Magnetic Reconnections

*NOWADA MOTOHARU[1], Quan-Qi Shi[1], Robert C. Fear[2], Chun-Feng Zhang[1], Yong Wei[4], Zhong-Hua Yao[3], Andrew Fazakerley[3], Sui-Yan Fu[5], Zu-Yin Pu[5]

1.Center for Space Weather Sciences, Institute of Space Science, School of Space Science and Physics, Shandong University at Weihai, 2.Space Environment Physics Group/Astronomy Group, Department of Physics and Astronomy, University of Southampton, 3.Mullard Space Science Laboratory, University College London, 4.Key Laboratory of Earth and Planetary Physics, Institute of Geology and Geophysics, Chinese Academy of Science, 5.Institute of Space Physics and Applied Technology, School of Earth and Space Sciences, Peking University

We present that TransPolar Arc (TPA), which was observed during magnetic reconnections at the cusp regions in northern/southern hemispheres and in the magnetotail, intensified when the magnetic flux at geosynchronous altitudes slightly piled up. The B_y component of Interplanetary Magnetic Field (IMF) during this TPA interval was dominantly negative (dawnward), and associated IMF-B_z component turned from negative (southward) to positive (northward) directions. We refer to the solar wind conditions four hours before the TPA interval because they correlate with the TPA's location and motion stronger than "current condition" which is estimated with the time delay between the solar wind and magnetospheric observational time. In this presentation, we also show how "current condition" IMF and associated plasmas were changing. Further discussion on the relation between the TPA brightening, intensification and two cases ("current"/"four hours before") of IMF condition will be made. One of the most interesting points in this event was that TPA's location has been biased and stagnant in post-midnight and dawn region for one hour of its duration.
On September 16th, 2001, Cluster made in-situ observation of the cusp reconnection in northern hemisphere, and detected strong acceleration of the solar wind electrons at the electron edge as formed by this cusp reconnection during TPA's appearance (On the details of this northern cusp reconnection event, see Nowada et al. "Cluster Observation of Electron Accelerations at the Electron Edges Formed by Localized Magnetic Reconnection at Cusp/Entry Region", submitted to J. Geophys. Res., 2016). On the ground, SuperDARN radar in the southern hemisphere simultaneously observed the ionospheric plasma flows whose velocity was faster than 0.6 km/s around the cusp footpoint region. These flows, which were faster than the background plasma velocity, suggest that magnetic reconnection occurred also at the cusp in the southern hemisphere. Adding these dual cusp magnetic reconnections, east-westward and west-eastward flows faster than 0.5 km/s were also observed over the region from pre- to post-midnight along the main auroral oval. These fast ionospheric flows support that the magnetotail reconnection also would occur. During this TPA's appearance, we found that the TPA's luminosity had intensified for 23 minutes, when GOES 10 observed slight enhancements of the B_z component and associated magnetic inclination angle between B_x and B_z components at geosynchronous altitudes. These magnetic field variations seen by the geosynchronous satellite suggest that the magnetic flux pileup in near-earth magnetotail plays a significant role in the intensification of the TPA's luminosity even though its amount is small. In this presentation, we will discuss further feasibility of the constellation study including the MMS fleet under this topic. In-situ magnetic reconnection signatures at northern cusp can be observed by Cluster in this event, but no satellites detected direct evidence for simultaneous reconnection process in the magnetotail, which was estimated and speculated by the ionospheric plasma flow patterns by SuparDARN radars on the ground.
In general, it has been believed that high energy source electrons for which TPA was formed are

generated by magnetic reconnection in the magnetotail or “twisted” plasma sheet due to an influence of the IMF-B_y component. However, the observations of TPA during which simultaneous magnetotail reconnection evidently occurs and/or those of the whole TPA formation process from the stage of energetic electron generation by the magnetotail reconnection to the transport process of the TPA’s source electrons to the ionosphere has not been conducted. We can understand the TPA’s physics more, if we could reveal a global view of TPA’s formation from both space- and ground-based observations.

Keywords: Transpolar Arc, Cusp and Tail Reconnections, Ionospheric Flows

