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定常状態における磁気圏 dynamics による Null-separator 構造が作る磁場構造の変形について

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Deformation of he null-separator structure by the plasma dynamics in the stationary magnetosphere

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The open magnetosphere model advocated by Dungey (1962) is accepted widely as the model of explaining the magnetosphere-ionosphere convection system. Later, the open model evolves into a 3D magnetic field topology formed by the solar wind-magnetosphere interaction [Cowley, 1973; Stern, 1973]. The null points and the separator lines characterize the 3D magnetic topology [Lau and Finn, 1990; Siscoe et al., 2000]. Identification of the null points and separator lines is useful to classify the topology mathematically, but it seems a symbolized one. For example, only information about the null points and the separator lines is not useful to understand the interaction between the magnetic field associated with the null-separator magnetic field topology and the plasma dynamics because only that information does not show the real configuration of the magnetic field. We newly developed a simple method of drawing the boundary surfaces between different magnetic field regimes. In the talk, we will present the preliminary results of the interaction between the magnetic field derived from the null-separator structure and the plasma dynamics in the stationary condition.

The main findings of this research are as follows;

1) The dipole magnetic field superposed by a uniform field forms a torus by closed field lines and, at the same time, two cylinders extending parallel and anti-parallel to the IMF direction [Lau and Finn, 1990]. In the solar wind environment, the two cylinders are extended anti-sunward direction by the solar wind and form the lobes in the northern and southern hemispheres. Furthermore, the cylinder in the vacuum condition is deformed to a narrow slot extending anti-sunward. The torus of the closed field lines is also extended anti-sunward direction by the solar wind. The plasma sheet is formed as a sandwiched region between the two cylinders. In the tail region behind the torus of the closed field lines (that is to say, the plasma sheet), the two cylinders are separated and the distance between the cylinders becomes gradually large. The magnetic field of the solar wind intrudes the wedge-type region between the two cylinders in the equatorial region beyond the plasma sheet.

2) The slot of the open field lines in the magnetotail plays an interesting role in the magnetospheric dynamics as the window across which plasma electromagnetic energy enters into the magnetosphere. When IMF is northward, the slot is located in the magnetopause near the plasma sheet. The magnetic field intensity is weaker there. Thus, this configuration promotes the plasma plume in the lobe. This mechanism of the plume will work with that explained by Ebihara and Tanaka [2016]. On the other hand, in the southward IMF condition, the slot appears apart from the plasma sheet in the magnetopause where the magnetic field intensity is rather stronger. Then, the plasma plume seems to be suppressed. The east-west width of the slot is wider in the southward IMF condition than in the northward one. Thus, the voltage difference across the slot (this voltage will be related to the cross-polar cap potential) becomes larger in the southward IMF condition.

3) Energy entry to the dayside magnetosphere in the separator reconnection depends on the north-south component of the IMF. In the northward IMF condition, the Poynting flux passing the morning side of the separator line in the northern hemisphere and the flux passing the afternoon side of the separator line in the southern hemisphere enter the magnetosphere. The Poynting flux passing the other regions does not enter the magnetosphere. This result seems to be related to interchange reconnection in the northward IMF condition [Watanabe et al., 2004]. In the southward IMF condition, all the solar-wind Poynting fluxes passing all regions around the separator line enter the magnetosphere. This result is consistent with the fact that magnetic field lines in a wide range are reconnected along the separator line in the southward IMF condition [Tanaka, 2007]. The Poynting flux entry in the northward IMF condition is almost confined to the polar cap region. On the other hand, the flux in the southward IMF condition arrives at not only the polar cap but also at the lower latitude region of the ionosphere.

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