

地球磁気圏における交換型リコネクションの位相と形状

Topology and geometry of interchange-type reconnection in the terrestrial magnetosphere

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Reconnection in which the topological regions of the two reconnecting field lines interchange at the time of reconnection is referred to as “interchange-type reconnection.” There exist two kinds of interchange-type reconnection in the terrestrial magnetosphere. One is reconnection of an interplanetary magnetic field (IMF) line and a lobe field line, and the other is reconnection of a lobe field line and a closed field line. For northward IMF, these two processes play a vital role in the convection system and form the “interchange cycle” associated with an ionospheric convection cell circulating exclusively in the closed field line region (called the “reciprocal cell”). Interchange-type reconnection occurs on a portion of the separatrix that is away from the separator, which contrasts with Dungey-type reconnection that occurs just on the separator. Despite of its importance, our understanding of the topological and geometrical nature of interchange-type reconnection is far from complete. The purpose of this study is to clarify the magnetic topology and geometry of interchange-type reconnection in the terrestrial magnetosphere using global magnetohydrodynamic (MHD) simulation. With the Reproduce Plasma Universe (REPPU) code, we obtained a quasi-steady magnetosphere associated with reciprocal cells under the IMF conditions of $B=6\text{nT}$ (total intensity) and $\theta=20^\circ$ (clock angle). The global magnetic topology of the magnetosphere is characterized by two magnetic null points and two separators connecting the nulls (which we call the separator circle). We tracked the separatrix surface emanating from each null, using the geodesic level set algorithm described by Krauskopf & Osinga (1999). The two diffusion regions on the separatrix surface (one to the dawnward of the separator circle and the other to the duskward of the separator circle) are both situated on a line passing through the null point elongating in the dawn-to-dusk direction. Each linear diffusion region corresponds to the so-called X line. The direction of the plasma flow passing through the separatrix surface reverses on the X line. We also determined the geometric configuration of the reconnecting and reconnected field lines near the X line. From the field line topology and the X line location, interchange-type reconnection is interpreted to be a variant of “fan reconnection” analytically modelled by Priest & Titov (1996).

Krauskopf & Osinga (1999). *Chaos* 9, 768–774. <https://doi.org/10.1063/1.166450>

Priest & Titov (1996). *Phil. Trans. R. Soc. A*.354, 2951–2992. <http://doi.org/10.1098/rsta.1996.0136>

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