Visualizing field-aligned electric fields associated with interchange-type reconnection

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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. In the terrestrial magnetosphere, a well-known interchange process is reconnection of an interplanetary magnetic field (IMF) line and a lobe field line. Another less-known but important interchange process is reconnection of a lobe field line and a closed field line. These reconnection processes play a vital role for northward IMF and manifest themselves as the "interchange cycle" that results in 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 nature of interchange-type reconnection is far from complete. The purpose of this study is to clarify the magnetic topology of interchange-type reconnection using global magnetohydrodynamic (MHD) simulation. As a first step, we visualized the reconnection electric fields on separatrices responsible for interchange-type reconnection. Using the Reproduce Plasma Universe (REPPU) code (Tanaka, 2015), under the IMF conditions of B=6nT (total intensity) and θ=20° (clock angle), we obtained a quasi-steady magnetosphere with reciprocal cells in the ionosphere. The global magnetic topology of the magnetosphere is characterized by two magnetic null points and two separators connecting the nulls. We traced the separatrix emanating from each null, using the geodesic level set algorithm described by Krauskopf & Osinga (1999). The field-aligned electric fields on the separatrix surface is directed dusk-to-dawn for both nulls and for both IMF-lobe and lobe-closed separatrices. These electric fields indicate the presence of two kinds of interchange-type reconnection described above. In the talk, we will further discuss the geometry of field lines participating in reconnection.

References

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