Dynamics of Magnetic Field Topology in Global 3D EM Particle Simulation

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The dynamics of the magnetic field topology is analyzed with a new version of a global three-dimensional full particle simulation code in the magnetotail as the southward interplanetary magnetic field (IMF) interacts with the Earth magnetosphere. We have investigated the temporal evolution of magnetic field topology (FT) and its bifurcations, i. e. “magnetic reconnection” in the magnetotail with the southward IMF. According to the FT theory, the magnetic field topology is uniquely determined by the signs of real part of Jacobian matrix eigenvalues of the critical points (CPs) i. e., magnetic nulls, if their Jacobian matrix of the critical points is not degenerated. The FT can be changed only at CPs and the signs of the real part of eigenvalues characterize the magnetic field patterns around CPs. The CPs can be classified to four different types of “saddles point”. In the saddles points, the eigenvectors span characteristic one and two-dimensional manifolds. These manifolds and CPs forms FT skeletons and determine the FT globally. CPs are connected each other and forms “X-lines” or “Saddle connection”. These FT skeletons or “saddle connections” that include the CPs, characteristic curves, and surfaces, which are spanned by the eigenvectors of their CPs, provide a view of the 3D FT. The change of the skeleton, i.e. the change of the FT is the “bifurcation” and, has revealed the occurrence of the magnetic reconnections.