Visualizing Magnetospheric Topology in Global 3D MHD Simulations

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This report focuses on visualizing a global three-dimensional magnetospheric field topology. A global magnetospheric field topology can be determined by the combinations of types of nulls in the magnetic field, where all the nulls are saddle points due to the solenoidal condition, and we obtain the eigenvalues of nulls and determine the so-called saddle connections (for examples, Arnold and Silverman, 1978). We apply the visualization algorithm by Krauskopf and Osinga (1999) to visualize the global earth magnetic field topology in a northward interplanetary magnetic field (IMF) from a 3D global MHD (Magneto-Hydro-Dynamic) simulation. In so doing, we determine the two-dimensional and one-dimensional stable or unstable manifolds, respectively, are computed from the nulls found in a 3-D global MHD simulation to visualize 3D magnetospheric topology. Present results show that (i) first time, the theoretical magnetic field topology by Lau and Fin (1990) are recovered, (ii) the magnetospheric manifold spanned by the null near the north pole is very complicate than that near the south pole, (iii) the neutral line can be determined as the saddle connecting lines, and (iv) the global magnetospheric topology may lead to understanding the magnetospheric dynamics better.

Keywords: topology, saddle connection