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Magnetic nulls in three-dimensional kinetic simulations of space plasmas

Vyacheslav Olshevsky (1,5), Jan Deca (2,6), Andrey Divin (3), Ivy Bo Peng (4), Stefano Markidis (4), Maria Elena Innocenti (1), Emanuele Cazzola (1), and Giovanni Lapenta (1)

(1) Center for mathematical Plasma Astrophysics, KU Leuven, Belgium, (2) Laboratory for Atmospheric and Space Physics (LASP), University of Colorado Boulder, USA, (3) St. Petersburg State University, St. Petersburg, Russia, (4) High Performance Computing and Visualization (HPCViz), KTH Royal Institute of Technology, Stockholm, Sweden, (5) Main Astronomical Observatory of NAS, Kyiv, Ukraine, (6) Institute for Modeling Plasma, Atmospheres and Cosmic Dust, NASA/SSERVI, Boulder, Colorado, USA

We present a survey of magnetic nulls and associated energy dissipation in different three-dimensional kinetic particle-in-cell simulations of space plasmas. The configurations under study include: a traditional Harris current sheet and current sheets with asymmetric density distribution, dipolar and quadrupolar planetary magnetospheres, lunar magnetic anomalies, and decaying turbulence. Nulls are detected in the simulation snapshots by the topological degree method. In all runs except the quadrupolar magnetospere the dominating majority of nulls are of spiral topological type. When supported by strong currents, these nulls indicate the regions of strong energy dissipation. Dissipation, often accompanied by the changes in magnetic topology, is caused by plasma instabilities in the current channels or on their interfaces. Radial nulls show less activity, they can be created or destroyed in pairs, via topological bifurcations. Although such events demonstrate energy release, they are rather rare and short-living. An important implication of our study to observations is that magnetic topology should not be considered independently of other plasma properties such as currents.