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How to find magnetic null and construct field topology with MMS data?

Huishan Fu (1,2), Andris Vaivads (2), Yuri Khotyaintsev (2), Vyacheslav Olshevsky (3,4), Mats Andre (2), Jinbin Cao (1), Shiyong Huang (5), Alessandro Retino (5), and Jonathan Eastwood (6)

(1) Space Science Institute, School of Astronautics, Beihang University, Beijing, China (huishanf@gmail.com), (2) Swedish Institute of Space Physics, Uppsala, Sweden, (3) Center for mathematical Plasma Astrophysics, Department of Mathematics, KU Leuven, Leuven, Belgium, (4) Main Astronomical Observatory of NAS, Akademika Zabolotnoho 27, 03680 Kyiv, Ukraine, (5) Laboratoire de Physique des Plasmas, CNRS/Ecole Polytechnique/UPMC, Palaiseau, France, (6) The Blackett Laboratory, Imperial College London, London SW7 2AZ, United Kingdom

In this study, we apply a new method—Taylor expansion—to find magnetic null and construct magnetic field topology, in order to use it with the data from the forth-coming MMS mission. We compare this method with the previously used Poincare index (PI), and find that they are generally consistent, except that the PI method can only find a null inside the spacecraft (SC) tetrahedron, while the Taylor expansion can find a null both inside and outside the tetrahedron and also deduce its drift velocity. Taylor expansion can also: (1) avoid the limitations of PI method such as data resolution, instrument uncertainty (Bz offset), and SC separation; (2) identify 3D null types (A, B, As, and Bs) and determine whether these types can degenerate into 2D (X and O); (3) construct the magnetic field topology. We quantitively test the accurateness of Taylor expansion in positioning magnetic null and constructing field topology, by using the data from 3D kinetic simulations. The influences of SC separation (from 0.05 to 1 d_i) and null-SC distance (from 0 to 1 d_i) on the accurateness are both considered. We find that: (1) for single null, the method is accurate when the SC separation is smaller than 1 d_i, and the null-SC distance is smaller than 0.5 d_i (weakly chaotic reconnection) or 0.25 d_i (strongly chaotic reconnection); (2) for null pair, the accurateness is same as the single-null situation, except at the null-null line, where the field is nonlinear. We invent a parameter $\xi \equiv |(\lambda_1 + \lambda_2 + \lambda_3)|/|\lambda|_{\max}$ to quantify the quality of the method—the smaller this parameter the better the results. Comparing to the previously used one ($\eta \equiv |\nabla \cdot \mathrm{B}|/|\nabla \times \mathrm{B}|$), this parameter is more relevant. Using the new method, we construct the magnetic field topology around a radial-type null and a spiral-type null, and find that the topologies are well consistent with those predicted in theory. This means that our method is reliable. We therefore suggest using this method to find magnetic null and construct field topology with the four-point measurements, particularly the Cluster and forth-coming MMS measurements.