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Optimal Use of Time Lags Between MMS Spacecraft : Application to the Estimation of Wave-Vectors

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Due to the last generation of detectors and sensors the MMS mission has exceptional capabilities to exploit time lags at small scales between its four spacecraft. Turner et al. (2017) have taken advantage of these capabilities to make a detailed investigation of the properties of whistler mode chorus elements in the inner magnetosphere. In particular they made use of cross-correlations of SCM quasi monochromatic data between pairs of spacecraft to estimate phase lags and to derive wave vectors. For a given event the three components of the wave vector can be estimated by considering a triplet of non-coplanar pairs of spacecraft. There are 16 such triplets leading to 16 estimated wave vectors : the mean values and standard deviations of these estimates are kept as the nominal wave vector and uncertainty. It happens that some of the 16 triplets are better than others ; is there an objective criterion to find the best ones ? A new approach has been developped to revisite this study. For a cluster of four spacecraft there are six pairs of spacecraft, each one giving raise to a scalar equation relating the vector position R from the first to the second spacecraft, the wave vector K and the phase lag $\Delta\varphi$: R.K=$\Delta\varphi$. This over-determined system is solved by computing the pseudo inverse of the matrix M acting on the wave vector on the lhs of the equation. Similarly to the method used by Turner et al. this approach does not discriminate between good and bad pairs of spacecraft. Thus the system is modified by attributing a priori a positive weight to each equation (wj, j=1 to 6) constrained by $\sum$wj=1. Then a statistical ensemble of 6-uplets (wj, j=1 to 6) is built ; for each element of this ensemble we compute the condition number of matrix M and we look for the 6-uplet giving the lowest condition number. This procedure warrants the best accuracy of the pseudo-inverse of M and hence the best estimate of the wave vector K. Adding random perturbations to M and $\Delta\varphi$ the procedure allows to estimate the uncertainties on K.

Reference

Turner, D. L., Lee, J. H., Claudepierre, S. G.,Fennell, J. F., Blake, J. B., Jaynes, A. N., Santolik, O. (2017). Examining coherency scales, substructure, and propagation of whistler mode chorus elements with Magnetospheric Multiscale (MMS). Journal of Geophysical Research: Space Physics, 122, 11,201–11,226. https://doi.org/10.1002/2017JA024474