EGU22-4018
https://doi.org/10.5194/egusphere-egu22-4018
EGU General Assembly 2022

Revisiting the wave telescope for larger numbers of spacecraft

Leonard Schulz[1], Karl-Heinz Glassmeier[1,2], Ferdinand Plaschke[1], and Uwe Motschmann[3,4]
[1]Technische Universität Braunschweig, Institut für Geophysik und extraterrestrische Physik, Braunschweig, Germany
[2]Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany
[3]Technische Universität Braunschweig, Institut für theoretische Physik, Braunschweig, Germany
[4]Deutsches Zentrum für Luft- und Raumfahrt, Institut für Planetenforschung, Berlin, Germany

The strong growth of the space sector along with the use of smaller satellites, for example Cubesats, has fueled the rising implementation of satellite constellations. Not only in commercial spaceflight small satellite constellations are used frequently - there also have been ideas put forward for scientific missions using constellations exceeding the 4 spacecraft constellations previously used for in-situ multi-point measurements in space plasma physics (e.g. CLUSTER or MMS). Thus, there is a need to expand current analysis techniques of those multi-point measurements to more than 4 spacecraft and characterize the benefits of a larger number of satellites. Such an analysis technique is the wave telescope, e.g. introduced in Motschmann et al., 1996. The wave telescope allows to use e.g. magnetic field data from different points in space (the different spacecraft) to estimate a spatial fourier transform and with that is able to detect multiple waves. Thus, using a confined time interval, the frequency and wave vector of several different waves can be detected with high precision. Since its introduction, the wave telescope has been successfully applied for detection of waves in in-situ magnetic field data from Earth's magnetospheric environment. Using artificial data of magnetic plane waves in simulations, we revisit the limitations of the wave telescope for satellite numbers of 4 or less and explore the quality of detection for satellite configurations of 5 and more spacecraft. We present structured analysis of the spatial analysis limit from 1D upwards, named the nyquist wavenumber or wave vector (analogous to the nyquist frequency in the frequency domain). Additionally, we show that the wave telescope suffers from so called spatial blindness when the chosen satellite configuration is not moving and non-random phase plane waves at the same frequency are present. This blindness reduces the possible number of waves detected to no more than one.