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Optimized Reciprocal Vectors for Estimating Gradients of Physical Fields from Multi-Spacecraft Missions

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Reciprocal Vectors of the tetrahedron have been used since the beginning of the CLUSTER mission for estimating gradients of physical fiels, either scalar (density) or vector (magnetic field). An introduction to the method was given in chapter 14 of the ISSI book SR001 published in 1998 "Analysis Methods for Multi-Spacecraft Data", and an updated review of the method has been presented in the second ISSI book SR008 "Multi-Spacecraft Analysis Methods Revisited" in 2008. This method encompasses the curlometer tool based on Ampère's theorem, moreover it allows a detailed analysis of errors affecting the estimated gradients and it handles symmetrically the four spacecraft. The quality of the estimated gradient depends upon the proximity of the real tetrahedron to the regular tetrahedron : geometrical errors due to uncertainties in spacecraft positions grow rapidly when the tetrahedron is flat or elongated. A new approach has been designed to remedy this caveat to some extent. By contrast to the original method Generalized Reciprocal Vectors (GRV's)result from the search of an optimal weighting of the data provided by the four spacecraft. We will present applications to MMS cases during crossings of current sheets.