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Parallel Transport, Non-local Calculus, and the Smoothing of Spacetime

A procedure is developed to average tensor fields over simply connected differentiable manifolds. Parallel transport in metric affine spaces is reviewed and arguments are made to ensure that an averaging procedure be well defined. We argue that in a Riemannian space (V_n) only parallel transport along geodesics provides for a well-defined averaging procedure. Alternatively, if one wishes to develop a well-defined averaging procedure that is independent of the path used for parallel transport, then one must use a Weitzenbock connection on a flat manifold (a space of distant parallelism or W_n). With these preliminaries, we define the average of a tensor field over a finite region in both V_n and W_n spaces, and conclude with comparisons to some of the other averaging procedures.