

A new Laplacian acting on tensor fields: potentials, and Hodge decompositions

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Abstract

In arbitrary semi-Riemannian manifolds, I will introduce a recently constructed Laplacian operator acting on tensor fields of arbitrary rank. This Laplacian is based on the "covariant exterior differential and co-differential" acting on the blocks of the tensor fields when viewed as r -fold forms. It has very good properties and allows us to introduce potentials for the tensor fields in a manner analogous to that of the local Hodge decomposition theorem. These potentials are relevant in physical applications, in particular the potentials for the curvature tensors.

Harmonic tensors can be defined according to the new Laplacian. For proper Riemannian manifolds, a Hodge decomposition for arbitrary tensor fields seems to be feasible, and some partial results will be presented. For Lorentzian manifolds, the Laplacian and its relatives are related to a well-defined first order symmetric hyperbolic system of equations whose hyperbolizations are related to some mathematical energy tensors.