Surface charges in tetrad variables

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Abstract

Covariant phase space methods provide powerful tools to compute surface charges and conservation or balance laws in general relativity. However, a subtlety arises when applying them to tetrad variables: the symplectic potential that can be read directly from the action is not Lorentz gauge-invariant, even though the action is. This leads to a definition of the phase space that differs from general relativity because of additional charges associated with the internal Lorentz transformations, that make in particular the derivation of the first law of black hole mechanics ambiguous. We compare the covariant phase space methods with the alternative approach based on the variational bicomplex used by Barnich and Brandt, and highlight the same problem with the Lorentz charges. We then show that the situation can be improved by identifying a fully gauge-invariant potential, and prove the independence of the first law from the ambiguities of the potential, as in the metric case. Time allowing, we will present more recent work on the extension of the surface charges in tetrad variables to gravitational multipoles.