Conformal mass in AdS Quadratic Curvature Gravity

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Abstract

In the context of asymptotically anti-de Sitter (AdS) gravity, the physical information on conserved charges is encoded in the electric part of the Weyl tensor, as given by the Ashtekar-Magnon-Das (AMD) definition of *Conformal Mass* [1]. On the other hand, in the AdS sector of Quadratic Curvature Gravity (QCG), given by the action

$$I_{\mathrm{QCG}}^{\mathrm{ren}} = \int_{\mathcal{M}} d^{d+1}x\sqrt{-g}\left[\frac{1}{\kappa}\left(R-2\Lambda_0\right)+\alpha R_{\mu\nu}R^{\mu\nu}+\beta R^2+\gamma\, GB\right]+c_d\int_{\partial\mathcal{M}} d^dx\, B_d\left(K,\mathcal{R}\right), \quad (1)$$

the addition of extrinsic counterterms provides a finite Noether charge $Q[\xi]$. Here, GB is the Gauss-Bonnet term and $B_d\left(K,\mathcal{R}\right)$ is the Kounterterm series [2]. The conserved charges are then expressed as an integral on a codimension-2 surface Σ as to

$$Q[\xi] = \int_{\Sigma} d^{d-1}x\sqrt{\sigma}\, u_i\, q^i_j\, \xi^j\,, \quad (2)$$

where q^i_j is the charge density tensor, $\{\xi^i\}$ is a set of asymptotic Killing vectors, σ is the determinant of induced metric on Σ and u_i is a unit vector, normal to Σ. The particular form of q^i_j for this theory can be found in refs. [3, 4]. In the present talk, it is shown that, for asymptotically AdS spaces, the renormalized charge in QCG (2) can be consistently truncated to an AMD form, linear in the Weyl tensor, defining Conformal Mass in this theory,

$$\mathcal{H}[\xi] = -\Xi_d\frac{\ell_{\mathrm{eff}}}{8\pi G}\int_{\Sigma} d^{d-1}x\sqrt{\sigma}\, u_i\,\mathcal{E}^i_j\,\xi^j\,, \quad (3)$$

where ℓ_{eff} is the AdS effective radius and $\mathcal{E}^i_j = \frac{1}{d-2}W^{i\mu}_{j\nu}n_\mu n^\nu$ is the electric part of the Weyl tensor, in terms of the unit normal vector of the boundary, n_μ. The overall factor Ξ_d captures the information on the couplings of the gravity theory and poses an obstruction to the linearization of the charge [5]. In bold contrast to the Lovelock case, where Ξ_d is proportional to the degeneracy condition, for QCG, said factor is proportional to the relation which defines *criticality* in higher-derivative theories.

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