Brown-Henneaux's Canonical Approach to Topologically Massive Gravity

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The three dimensional gravity with negative cosmological constant admits a globally AdS_3 geometry as a vacuum [1], and the black hole solution of Bañados, Teitelboim and Zanelli (BTZ) [2] as excited states. By using a canonical formalism of the Einstein-Hilbert gravity, Brown and Henneaux [3] successfully constructed left- and right-moving Virasoro algebras of two dimensional conformal field theory at the boundary, whose central charges are given by $c_L = c_R = \frac{3\ell}{2G_N}$.

Furthermore, Saida and Soda [4] have previously studied the higher derivatives without the Chern-Simons term. By applying frame transformation method, they mapped the higher derivative action to the canonical Einstein-Hilbert one, and calculated the modification of the Virasoro central charges according to the Brown and Henneaux's argument.

In our work [5], we directly generalize the calculation of ref. [3] or [4] by including the gravitational Chern-Simons term. Such a three dimensional theory with negative cosmological constant is often referred to as topologically massive gravity (TMG). Although the asymptotic symmetry of the BTZ black hole in TMG is again described by the left and right moving Virasoro algebras, their central charges are not the same. They are found as

$$c_L = \frac{3\ell}{2G_N}\left(1+\frac{\beta}{\ell}\right), \qquad c_R = \frac{3\ell}{2G_N}\left(1-\frac{\beta}{\ell}\right). \tag{1}$$

The Cardy's entropy from these central charges exactly agrees with the Wald's black hole entropy. The M5-brane system is illustrated as an application of the present calculation.

References

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