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Aspects of horizon entropy in Lanczos-Lovelock gravity and Action principle for the fluid/gravity correspondence

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In this talk, we explore the thermodynamic nature of horizons in two parts:
We compare the expressions of entropy obtained in two different approaches. In the 'extrinsic' approach, we evaluate the entropy of a configuration of densely packed gravitating shells on the verge of forming a black hole in Lanczos-Lovelock theories of gravity. We find that this matter entropy is not equal to (it is less than) Wald entropy, except in GR, where they are equal. In the 'intrinsic' approach, we consider the Euclidean action of Lanczos-Lovelock models for a class of spherically symmetric metrics off-shell. We show that one can interpret it as the free energy and read off both the entropy and energy of a black hole spacetime to be exactly equal to the Wald entropy and the quasi-local energy of the spacetime in Lanczos-Lovelock models obtained by other methods.
We know that Einstein's field equations when projected onto any null surface look very similar to a Navier-Stokes equation which is reminiscent of the Membrane paradigm for black holes. We develop an action principle, the extremization of which leads to the above result, in an arbitrary spacetime. The degrees of freedom varied in the action principle are the null vectors in the spacetime and not the metric tensor. We further show that the action can be given a thermodynamic interpretation of describing an on-shell local entropy density of the spacetime. The null surface is found to obey an equation of state of the form PA = TS which continues to hold even in higher curvature theories such as Lanczos-Lovelock theories.

References: 1) S. Kolekar, D. Kothawala & T. Padmanabhan (2011), Phys.Rev.D 85, 064031. arXiv:1111.0973]. 2) S. Kolekar & T. Padmanabhan (2011), Phys.Rev.D 85, 024004. [arXiv:1109.5353]. 3) S. Kolekar & D. Kothawala (2012), Membrane Paradigm and Horizon Thermodynamics in Lanczos-Lovelock gravity, JHEP 1202, 006 [arXiv:1111.1242].