



Contribution ID: 109

Type: **not specified**

Null Surface Thermodynamics

Tuesday 22 March 2022 14:00 (1h 20m)

We study D dimensional pure Einstein gravity theory in a region of spacetime bounded by a generic null boundary. We show besides the graviton modes propagating in the bulk, the system is described by boundary degrees of freedom labeled by D surface charges associated with nontrivial diffeomorphisms at the boundary. We establish that the system admits a natural thermodynamical description. Using standard surface charge analysis and covariant phase space method, we formulate laws of null surface thermodynamics which are local equations over an arbitrary null surface. This thermodynamical system is generally an open system and can be closed only when there is no flux of gravitons through the null surface. Our analysis extends the usual black hole thermodynamics to a universal feature of any area element on a generic null surface in a generic diffeomorphism invariant theory of gravity.

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