

Thermodynamical study on universal horizons in higher D -dimensional spacetime and aether waves

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We investigate behaviors of the D -dimensional gravity coupled to a dynamical unit timelike vector, the aether, present two kinds of exact charged solutions and study the linearized wave spectrum of this theory. There is an universal horizon behind the Killing horizon in these aether black holes. We find that in the uncharged case, one can construct a Smarr formula and the (slightly modified) first law of black hole mechanics at the universal horizons for both kinds of black holes. An entropy can be associated with the universal horizon and a temperature can be defined there. For the second kind aether black hole and for the first kind one in the extremal higher dimensions, the charge should be severely constrained that $\bar{Q} \ll \bar{r}_0/2$. In this way, one can still construct such first law. For aether wave, our results show that the spin-1 and spin-2 modes are the same as those in 4-dimensional spacetime, and only the spin-0 one is different and dependant on the dimension number n .

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