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Page Curve of an Eternal Black Hole from Doubly Holographic Setup in M Theory

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Exploration of entanglement entropy and obtaining the Page curve in the context of eternal black holes associated with top-down holographic duals of QCD-like theories at high temperatures and intermediate coupling, has been missing in the literature. In this talk, I will explain how we obtain the Page curve of an eternal black hole relevant to the M-theory dual of thermal QCD-like theories at high temperatures and intermediate coupling (effected via inclusion of terms quartic in curvature in M-theory). We consider two candidate surfaces: Hartman-Maldacena-like surface and the island surface in the context of the aforementioned eternal black hole. We calculate the entanglement entropy contribution from both these surfaces, using Dong's formula for higher derivative gravity theories. Entanglement entropy contribution from Hartman-Maldacena surface has (an approximate) linear time dependence and diverges at late times. After the Page time, the entanglement entropy contribution from the island surface dominates which saturates the linear time growth of the entanglement entropy of the Hawking radiation and we obtain a (near) perfect Page curve. Interestingly, we found consistency between the Page curve obtained from computation of areas of Hartman-Maldacena-like and island surfaces with the Page curve obtained earlier using Dong's formula at $O(\beta^0)$ and $O(\beta^0)$ contribution to the entanglement entropy from Hartman-Maldacena-like surface provides us "Swiss-Cheese" structure in "Large" N "Scenario". Finiteness of ratio of entanglement entropy of the island surface to the thermal entropy and positivity of Page time requires lower and upper bound on the black hole horizon radius. Further, with the inclusion of the $O(R^4)$ terms in M theory, the turning point associated with the HM-like surface/IS being in the deep IR, results in a relationship between l_p and r_h along with a conjectural $e^{-O(1)N^{1/3}}$-suppression (motivated by $S_{EE}^{IS,\beta^0}/S_{BH} \sim 2$). We obtain a hierarchy with respect to this N-dependent exponential in S_{EE}^{HM,β^0}, $S_{EE}^{IS,\beta^0}(O(\beta^0))$ and $S_{EE}^{HM,\beta}$, $S_{EE}^{HM,\beta}(O(\beta))$.

Session

Formal Theory

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