

Near-extremal dynamics away from the horizon

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Near-extremal black holes are usually studied by zooming into the throat that describes their near-horizon geometry. Within this throat, one can argue that two-dimensional JT gravity is the appropriate effective theory that dominates at low temperature. Here, we discuss how to capture this effective description by standing far away from the horizon. Our strategy is to construct a phase space within gravitational theories in AdS that fixes the radial dependence while keeping the transverse dependence arbitrary. This allows us to implement a decoupling limit directly on the phase space while keeping the coordinates fixed. With this, we can relate the effective description in JT gravity to the CFT description at the boundary of AdS, which we do explicitly in AdS and non-rotating configurations in AdS. From the perspective of the dual CFT, our decoupling limit should be understood as a flow between a CFT and a near-CFT. Our analysis shows that local counterterms can be constructed in the near-CFT, which arise from the anomalies (or absence of them) in the CFT. We show that one of these counterterms is the Schwarzian effective action, making this sector a scheme-dependent choice. This illustrates the delicate interplay between a far and a near analysis of near-extremal black holes.

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