“Near extremal black holes through the lens of Lightcone modular bootstrap”

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1 Title and Abstract

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Abstract: The physics of near extremal black holes in AdS$_3$ is captured by the Schwarzian theory, implying existence of a Schwarzian sector in holographic CFTs with large central charge $c$, specifically in the large spin states with twist accumulating to $\frac{c-1}{12}$. We expound on this by performing a rigorous CFT analysis using Tauberian technique, a widely used tool in the analytical number theory. We show that for a unitary modular invariant 2D CFT with fixed central charge $c > 1$, having a nonzero twist gap in the spectrum of Virasoro primaries, for sufficiently large spin $J$, there always exist spin $J$ operators with twist falling in the interval $(\frac{c-1}{12} - \varepsilon, \frac{c-1}{12} + \varepsilon)$ with $\varepsilon = O(J^{-1/2} \log J)$. We establish that the number of Virasoro primary operators in such a window has a Cardy-like i.e., $\exp \left[ 2\pi \sqrt{\frac{(c-1)J}{6}} \right]$ growth. A similar result is then proven for a family of holographic CFTs with the twist gap growing linearly in $c$ and a uniform boundedness condition, in the regime $J \gg c^3 \gg 1$. Our result sheds light on the validity regime of Schwarzian approximation in describing the near-extremal rotating BTZ black holes (without electric charge). We make further conjectures on potential extension of the above results to CFTs with conserved currents. The talk will be based on arXiv:2307.02587 [hep-th] with Jiaxin Qiao and an earlier work arXiv:2212.04893 [hep-th] with Jiaxin Qiao and Slava Rychkov.