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Holographic renormalized Entanglement and entropic $c-$function

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We compute holographic entanglement entropy (EE) and the renormalized EE in AdS solitons with gauge potential for various dimensions. The renormalized EE is a cutoff-independent universal component of EE. Via Kaluza-Klein compactification of S^1 and considering the low-energy regime, we deduce the $(d-1)$-dimensional renormalized EE from the odd-dimensional counterpart. This corresponds to the shrinking circle of AdS solitons, probed at large l. The minimal surface transitions from disk to cylinder dominance as l increases. The quantum phase transition occurs at a critical subregion size, with renormalized EE showing non-monotonic behavior around this size. Across dimensions, massive modes decouple at lower energy, while degrees of freedom with Wilson lines contribute at smaller energy scales.

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