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Higher-derivative holography with a chemical potential

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We carry out an extensive study of the holographic aspects of any-dimensional higher-derivative Einstein-Maxwell theories in a fully analytic and non-perturbative fashion. We achieve this by introducing the d-dimensional version of Electromagnetic Quasitopological gravities: higher-derivative theories of gravity and electromagnetism that propagate no additional degrees of freedom and that allow one to study charged black hole solutions analytically. These theories contain non-minimal couplings, that in the holographic context give rise to a modified <JJ> correlator as well as to a general <TJJ> structure whose coefficients we compute. We constrain the couplings of the theory by imposing CFT unitarity and positivity of energy (which we show to be equivalent to causality in the bulk) as well as positive-entropy bounds from the Weak Gravity Conjecture. We also obtain the charged Rényi entropies and we observe that the chemical potential always increases the amount of entanglement and that the usual properties of Rényi entropies are preserved if the physical constraints are met. Finally, we compute the scaling dimension and magnetic response of twist operators and we provide a holographic derivation of the universal relations between the expansion of these quantities and the coefficients of <JJ> and <TJJ>.

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