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The rise and fall of the black hole chemistry

We reconsider the thermodynamics of AdS black holes in the context of gauge-gravity duality. In this new setting where both the cosmological constant Λ and the gravitational Newton constant G are varied in the bulk, we rewrite the first law in a new form containing both Λ (associated with thermodynamic pressure) and the central charge C of the dual CFT theory and their conjugate variables. This has the very interesting consequence that varying bulk pressure (as done in the black hole chemistry literature) no longer qualitatively changes phase diagrams. Their qualitative behavior depends entirely on the value of the central charge –in particular, phase transitions of charged black holes only exist provided the dual CFT has a sufficient number of degrees of freedom. In this sense our work marks “the fall” of black hole chemistry as traditionally understood, but opens up a new frontier for exploring its relationship with the AdS/CFT correspondence.

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