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Dual holography from a non-perturbative generalization of the Wilsonian RG framework

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In my opinion, physics is to aim understanding the macroscopic universal IR physics from the microscopic individual UV physics based on the first principle. The Wilsonian renormalization group (RG) framework would be the first organization principle. Unfortunately, this theoretical framework has its limitation in describing many long-standing physics problems, where the RG flow from UV to IR is nonperturbative in nature and beyond the paradigm of spontaneous symmetry breaking. In this talk, we discuss how to generalize the Wilsonian RG framework in a nonperturbative way. First, we introduce a brute-force way of RG transformations. Remarkably, the resulting Wilsonian effective action contains a particular class (most singular) of quantum corrections in the all-loop order, not exact but completely nonperturbative in nature. We confirm this nonperturbative physics explicitly from the Kondo problem, which shows the asymptotic freedom (decoupled local moment fixed point) at UV and confinement (local Fermi liquid fixed point) at IR. Although this brute-force way of RG transformations is explicit, the intermediate procedure looks dirty and hidden, involved with the heat-kernel calculation in a general background. We realize that there exists a topological structure in this brute-force construction. Second, we discuss an elegant reformulation of the previous nonperturbative RG theoretical framework, referred to as a cohomological-type topological field theory construction a la Witten. We demonstrate that this topological reformulation is essentially the same as the previous explicit derivation. Interestingly, we observe that this cohomological construction gives a deep connection to the path integral representation of the exact functional RG equation, where the RG flow of the probability distribution function is governed by the Fokker-Planck-type equation. Based on this novel reformulation, we discuss Weyl anomaly inflow and cancellation for the resulting renormalized effective action, regarded to be the consistency equation for the nonperturbative RG flow description. We see that all these mathematical structures are consistent with the holographic duality conjecture.

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