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Quantum Scale Invariance and Weyl Conformal Gravity

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Recent results in (quantum) scale invariance and its spontaneous breaking are presented. In flat spacetime, for a scale invariant theory the scalar potential is presented at three loops while keeping manifest scale symmetry. This is possible in a scale-invariant regularization (in $d = 4 - 2\epsilon$) in which the Goldstone (dilaton) of this symmetry generates (spontaneously) the subtraction scale (μ). Although non-polynomial (effective) operators are generated at the quantum level, suppressed by the (large) dilaton vev, a classical hierarchy of vev's (Higgs vs dilaton vev) is quantum stable. In curved spacetime, conformal symmetry and consistency (no ghosts) demands one introduce the Weyl gauge field ω_μ (and Weyl conformal geometry). In the {\it absence} of matter, Weyl's (conformal) quadratic gravity has spontaneous breaking (Stueckelberg mechanism) to Einstein action which is a "low-energy" effective theory below the mass of ω_μ (where the geometry becomes Riemannian). In the {\it presence} of matter (Higgs) with non-minimal coupling to Weyl gravity, the breaking of Weyl conformal symmetry triggers EW symmetry breaking. (arXiv:1812.08613, 1809.09174, 1712.06024)

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