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Naturalness, Wilsonian Renormalization, and 'Fundamental Parameters' in Quantum Field Theory

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Increasingly strong indications from the LHC that the Standard Model violates the naturalness principle raise several possibilities: 1) failure of naturalness is a genuinely problematic feature of the Standard Model that we should seek to correct in the search for deeper theories, 2) failure of naturalness is problematic, but a contingent fact of nature that we must simply accept, 3) failure of naturalness is unproblematic, and the naturalness principle should be abandoned. Exploring the third possibility, we closely examine one influential and inter-connected set of justifications for imposing naturalness in the particular senses that prohibit fine-tuning of the bare Higgs mass and delicate sensitivity to slight variations in bare parameters at the Standard Model's physical high-energy cutoff. We highlight the dependence of these justifications on the physical interpretation of these bare parameters as "fundamental parameters," which draws heavily on the well-known analogy between elementary particle physics and condensed matter theory. We argue that while failure of naturalness in these senses is legitimately regarded as problematic on this interpretation, there remains a viable alternative physical interpretation of these parameters that is under-recognized within the literature on naturalness, according to which there is nothing problematic or "unnatural" about the fine tunings or sensitivities in question. On this interpretation, all bare parameters, including those at an effective field theory's physical cutoff, are unphysical "auxiliary" parameters. We argue that this interpretation may be more appropriate to the context of elementary particle physics, implying that, despite the strong mathematical analogies between the quantum field theoretic formalisms of condensed matter theory and elementary particle physics, the particular forms of naturalness-based reasoning discussed here are undermined by strong *dis*analogies of physical interpretation of the formalism in these different contexts.

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