Solving the Naturalness Problem on Minimal Fractal Manifolds

Ervin Goldfain

Photonics CoE, Welch Allyn Inc., Skaneateles Falls, NY 13153, USA

Abstract

The "naturalness" problem stands out as one of the deepest mysteries of Quantum Field Theory (QFT) and General Relativity (GR). A vast array of proposals on how to tackle this challenge has been advanced over the years with no compelling experimental backup and no major breakthrough. In this brief report we re-emphasize that the onset of the minimal fractal manifold near or above the electroweak scale enables a straightforward resolution of this problem.

Key words: Naturalness problem, Fine-tuning, Hierarchy problem, Higgs mechanism, Electroweak scale, Cosmological constant, Vacuum energy density, Minimal fractal manifold.

The "naturalness" problem (NP) can be traced back to the enormous numerical difference separating three fundamental scales of QFT and GR: the energy scale of electroweak interaction (M_{EW}), the Planck scale (M_{Pl}) and the vacuum energy density expressed in terms of the cosmological constant ($\Lambda_{cc}^{1/4}$) [1-3]. The NP hypothesis is based on the assumption that the ratio

$$\varepsilon = \frac{\Lambda_{cc}^{1/4}}{M_{EW}} \sim \frac{M_{EW}}{M_{Pl}} = O(10^{-15}) \tag{1}$$

has a deep dynamical explanation that avoids the need for a tightly controlled fine-tuning of observables [1]. Many scenarios attempting to solve the NP have been put forward over the years, namely,

1) The Technicolor model,

2) Supersymmetry (SUSY),

3) Large Extra Dimensions models,

4) Warped Compactifications (Randall-Sundrum models),

5) Little Higgs theories,

6) Anthropic theories,

7) String/M theories,

8) Landscape and Multiverse scenarios.

Experimental evidence supporting either one of these attempts is currently non-existing. In this context, we re-emphasize that (1) follows naturally from placing QFT on a space-time support equipped with minimal deviations from four-dimensions $\varepsilon = 4 - D$, $\varepsilon << 1$ (called *minimal fractal manifold*) [4-12]. The interested reader is also directed to https://www.researchgate.net/profile/Ervin_Goldfain/publications for online access to many of our recent articles related to this topic.

References:

[1] http://arxiv.org/pdf/hep-th/0501082v1.pdf

[2] https://indico.cern.ch/event/290373/

[3] http://profmattstrassler.com/2014/11/17/at-the-naturalness-2014-conference/#comments

[4] E. Goldfain, "On a Natural Solution for the Hierarchy Problem Using Dimensional Regularization", *Prespacetime Journal*, **2**(3), (2011), pp. 437-439.

[5] E. Goldfain, "Dynamics of Neutrino Oscillations and the Cosmological Constant Problem", *Prespacetime Journal* **2**(3), (2011), pp. 442-446.

[6] E. Goldfain, "Fractal Spacetime as Underlying Structure of the Standard Model", *Quantum Matter*, **3**(3), (2014), pp. 256-263.

[7] E. Goldfain, "Fractional Field Theory and Physics Beyond the Standard Model", *Prespacetime Journal*, **3**(5), 2012, pp. 435-438.

[8] E. Goldfain, "Fractal Spacetime and the Dynamic Generation of Mass Scales in Field Theory", *Prespacetime Journal* **5**(9), 2014, pp. 843-851.

[9] E. Goldfain, "Fractional Field Theory and High-Energy Physics: New Developments" in *Horizons in World Physics*, 279, Nova Science Publishers, pp. 69-92 (2013).

[10] E. Goldfain, "Quantum Field Theory as Manifestation of Fractal Geometry", *Prespacetime Journal*, **4**(9), 2013, pp. 847-850.

[11] E. Goldfain, "The Seesaw Mechanism and the Structure of Spacetime above the Electroweak Scale", *Prespacetime Journal*, **5**(10), 2014, pp. 953-958.

[12] E. Goldfain, "Fractal Spacetime as Tentative Solution for the Cosmological and Coincidence Problems", *Prespacetime Journal*, **4**(8), pp. 740-747.