Minimal Fractal Manifold as Root Cause of Quantum Anomalies

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Abstract

Quantum anomalies describe the generic failure of classical symmetries to survive quantization. As side effect of regularization, anomalies involve two related aspects. On the one hand, quantum currents are products of operators defined at the same spacetime point and lead to singular behavior. On the other, the path-integral measure gives rise to transformations having non-unitary Jacobians. The goal of this work is to show that the root cause of quantum anomalies may be traced back to a spacetime endowed with arbitrarily small deviations from four-dimensions (the *Minimal Fractal Manifold*, MFM in short). The analysis hints that the MFM can naturally explain the relation between anomalies and index theorems. It also reveals an unforeseen connection between Dirac's chiral matrix and the dimensional parameter $\varepsilon = 4 - D << 1$.

Key words: Quantum anomaly, Regularization, Minimal Fractal Manifold, Gamma matrices, Index theorems.