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Fractal Path Integrals and its Degeneration to Dimensional Regularization

In this work we study particles propagate in fractal paths and use fractal derivatives to extend the dynamic dimension of Quantum Field Theory. We construct the Lagrangian of fractal scalar, vector and spinor fields to obtain their propagators by path integral. Then we compute the typical tree level and one loop diagrams which correspond to QED cases. The calculations show the dimension dependence of amplitudes. Additionally, in one loop calculation we obtain results which are consistent with dimensional regularization as the dimension approaches to the Standard Model value. Therefore, the fractal path integrals can be regarded as an equivalent theoretical description for regularizing the divergence in the normal Quantum Field Theory. We also derive the equation of motion for scalar, vector and spinor particles propagate in fractal paths and discuss the corresponding local gauge symmetries.

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