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Complex dynamics and the high-energy regime of quantum field theory ERVIN GOLDFAIN, OptiSolve Consulting — The Standard Model embodies our current knowledge of elementary particle physics and represents a well-tested framework for the study of non-gravitational phenomena at low energies. It is built on the foundations of relativistic quantum field theory (QFT), which provides the correct description of electroweak and strong interactions involving leptons and quarks. It is generally believed that, extending the validity of QFT to energies on or beyond the TeV range must include the unavoidable signature of vacuum fluctuations and strong-field gravity. The key premise of our work is that mathematical tools of fractional calculus and complexity theory are necessary to properly describe the high-energy regime of QFT. The random space-time topology associated with persistent vacuum fluctuations is represented using the fractional wave equation and the Levy flow model. The range of space-time correlations is encoded in the pair of Levy and memory indices, respectively(α, β). We report the following findings: i) relativistic gravitation emerges as a natural part of the picture if $\beta \neq 1$ and through the use of time fractional differential and integral operators. ii) up to a first order analysis, the Levy index α may be used to control convergence of Feynman diagrams and enable the dynamics to become fully renormalizable in all orders of perturbation theory. iii) gauge bosons and fermions emerge as condensates of space-time geometry resulting from fixing(α, β) in the process of cooling from the high-energy scale of TeV physics.

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