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Title: “A renormalizable topological quantum field theory for gravity”

Abstract: In 1989 E. Witten, using traditional QFT techniques, develop an exact path integral representation to many classes of topological invariants. These QFTs, so-called Topological QFTs (TQFTs), share the property that all of their observables are metric-independent. In other words, the observables are global invariants classifying the topological and smooth structure of spacetime. In this sense, one could say, that TQFTs are examples of background independent and exactly soluble perturbative QFTs.

One of the most proeminent example perhaps is the four dimensional Topological Yang-Mills theory (TYM). This theory can be obtained by the BRST quantization of the Pontryagin invariant $\int \mathrm{Tr}(FF)$, instead of the tradition Yang-Mills action $\int \mathrm{Tr}(F\star F)$. The observables are known to be the Donaldson’s polynomials, which classify the smooth structure of the underlying manifold. In particular, TYM theory is so symmetric that it has remarkably simple quantum properties. For instance, in the Landau gauge, it is actually finite (all quantum corrections vanish).

These remarkable properties led Witten to hypothesize if such a theory could describe an unbroken phase of General Relativity. In this talk, we will propose a renormalizable TYM theory that can generate gravity via an explicity breaking of its topological BRST symmetry - thus fulfilling Witten’s vision. In particular, we will consider the family of Lovelock-Cartan theories of gravity due to their generality and closer relation to the gauge structure.