Emergent Dimensions in Background Independent Quantum Gravity

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ABSTRACT

Abstract goes here.

I. INTRODUCTION

Background-independent models of spacetime geometry are increasingly common in the search for a quantum theory of gravity. If General Relativity is only an effective theory,

Introduction [1], [2], [3].

II. SECTION 1

A. Evolution of the Model

Given an undirected, loopless graph G with vertices $V(G) = \{1...N\}$ and edges $E(G)$, a Hamiltonian H can be defined on the graph as follows:

$$H = J \sum_{i,j \in V(G), i \neq j} (d_i - d_j)^2 + K \sum_{v \in V(G)} d_v \tag{1}$$

Where J and K are weighting constants, and d_i simply represents the degree (number of connected edges) of a given node. The first of the sum forces the graph to be regular in the low-temperature limit, while the second sum pushes the graph to be more or less connected depending on the value of K. As K goes to infinity, the expectation value of the average node degree drops to zero. Conversely, as K tends towards negative infinity, the expectation value of the average node degree should go to $N - 1$. A set of seed graphs are evolved according to this Hamiltonian using a Monte-Carlo simulation with a Metropolis algorithm.

III. GEOMETRICAL PROPERTIES OF GRAPHS

Geometrical properties of the graphs considered are defined as in [5]. This definition of dimensionality is computationally problematic, not due to the complexity of the algorithm but rather due to its fundamentally recursive nature. Calculating the dimensionality of a complete graph K_N on N nodes requires $N!$ recursive calls, which quickly becomes computationally intractable as N increases. Of course, K_N is just an N-1-dimensional simplex, but no such simplification exists for highly dense graphs close to K_N. While the graphs considered in the simulation were in general not so dense as to require such a high number of recursive calls, they were still complex enough to impose an upper limit on the size of the graphs considered.

The Euler Characteristic χ is equal to the sum of the curvatures at every node, as defined in [5]

IV. CONCLUSION

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