SPIN NETWORKS IN QUANTUM GRAVITY

MIGUEL LORENTE

Abstract.   This is a review of one of the approaches to unify Quantum Mechanics and the theory of General Relativity. Starting from the pioneer work of Regge and Penrose, other scientists have constructed state sum models, as Feymann path integrals, that are topological invariant on the triangulated Riemannian surfaces, and that become the Hilbert-Einstein action in the continuous limit.

1. Introduction

In this review we will present the main ideas of the spin foam approach. This line of research in quantum gravity has attracted a great deal of attention and been explored by many physicists and mathematicians.

However, we would first point out there are three main lines of research in quantum gravity denoted as "canonical", "covariant" and "sum over histories" [20].

The canonical line of research is a theory in which the Hilbert space carries a representation of the quantum operators corresponding to the full metric without background metric being fixed. It can be considered as a quantum field theory on a differentiable manifold. The basis of the Hilbert space are cylindrical functions defined on a graph (Wilson loops) depending on Ashtehar variables [21]. Very important results of this approach were the discrete eigenvalues for the area and volume operators.

The covariant line of research is the attempt to build the theory as a quantum field theory of the fluctuations of the metric over a flat Minkowski space, or some other background metric space. The theory has been proved to be renormalizable and finite order by order [1].

The sum over histories line of research uses the Feymann path integral to quantize the Einstein Hilbert action. A duality exists between this model and group field theories. The sum over spin foam can be generated as the Feymann perturbative expansion of the group field theories. Each space-time appears as the Feymann