

## Computational Aspects of Quantum Gravity: Numerical methods in spinfoam models

The spinfoam amplitude plays a crucial role in the spinfoam formulation by defining the transition amplitude of covariant Loop Quantum Gravity(LQG). Despite the novel and crucial analytic results in the spinfoam formulation, the computational complexity has been obstructed further explorations in spinfoam models. Nevertheless, numerical approaches to spinfoams open new windows to circumvent this obstruction.

We use numerical methods to analyze spinfoam amplitudes and correlation functions. We do the large- $j$  asymptotic expansion of spinfoam models. The next-to-leading order correction is studied numerically in the large- $j$  expansion of the Lorentzian EPRL 4-simplex amplitude. We also extend our previous method and numerically compute asymptotic expansion of spinfoam amplitude on the simplicial complex by taking into account sum-over  $j$ . We resolve long-standing confusion, known as the flatness problem, about whether the curved geometry exists in the semiclassical regime of the spinfoam amplitude.

Furthermore, we apply the Monte-Carlo method to numerically compute the EPRL spinfoam propagator on a 4-simplex. We obtain the numerical results of the propagators at different  $j$  and demonstrate their consistency with the expected spinfoam semiclassical behavior in the large- $j$  limit.