Corrections to the Friedmann Equations in LQC from Geometric Quantum Mechanics

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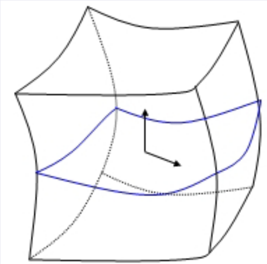
VT, Phys. Rev. D78 064072, 2008.

Motivation: Quantum Corrections at Late Times

- In quantum theory we work with an infinite dimensional Hilbert space.
- We wish to know if we can find a finite dimensional submanifold (isomorphic to the classical phase space) on which we can approximate the quantum dynamics by effective equations.
- Effective action methods are unsuitable for our model which is written in the Hamiltonian framework.
- Use the geometric quantum mechanics framework to obtain these effective equations.
- Numerical work has been done in the full quantum theory and we wish to check if the states evolved in the numerical work do remain sharply peaked and follow the trajectories given by the effective equations.

Fiber Bundle Structure



Framework (Cont.)

- Quantum phase space, i.e. Hilbert Space
- Taking expectation values of classical observables provides a natural projection from the quantum phase space to the classical phase space.
- So we can view the quantum phase space as a bundle over the classical phase space.
- Classical phase space

- T. Schilling, PhD Thesis, *Geometric Formulation of Quantum Mechanics*, Pennsylvania State University 1996.
- A. Ashtekar, T. Schilling, gr-qc/9706069

Corrected Friedmann Equation

We can compute the corrected Friedmann equation via

$$H^2 = \left(\frac{1}{3} \frac{\dot{V}}{V} \right)^2 = \frac{\kappa\rho}{3} \left(1 - \frac{\rho}{\rho_{crit}} \right) + O(\epsilon^2) \quad (1)$$

where

$$\rho_{crit} = \frac{3}{\kappa\gamma^2\Delta} \simeq 0.41\rho_p \quad (2)$$

Even though we are looking at a semiclassical approximation we see that gravity is already becoming repulsive.