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How classical are Gaussian states in loop quantum cosmology?

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In traditional (Dirac quantized) quantum mechanics, Gaussian wave functions play an important role in understanding semi-classicality: they may be chosen to be as sharply-peaked around classical position coordinates and they saturate the uncertainty relation, thereby minimizing quantum fluctuations. Gaussian states may likewise be constructed on the kinematic volume Hilbert space of loop quantum cosmology (LQC), and are often viewed as good candidates for semi-classical quantum geometries. However, it is not obvious that they exhibit the same nice features as traditional Gaussian quantum states. In this talk, I show that contrary to common intuition, Gaussian states in LQC generally do not saturate their uncertainty relations, and indeed, that there exist LQC Gaussian states for which the fluctuations are arbitrarily large. It is shown, however, that the usual volume regularization procedure of LQC allows one to suppress these diverging fluctuations as much as one wishes, and so uncertainty minimization is obtained asymptotically as $V_0 \to \infty$. It is further illustrated that the relationship between the fiducial volume V_0 and holonomy length λ plays an important role in determining the fluctuations of the these states.

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