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Initial Conditions in LQC/mLQCs

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The initial conditions are a subtle issue in loop quantum cosmology (LQC) and modified loop quantum cosmologies (mLQCs). This is mainly because in general there doesn't exist a preferred initial time and state for a quantum field in an arbitrarily curved space-time. If the universe is sufficiently smooth and its evolution is sufficiently slow, so the characteristic scale of perturbations
is much larger than the wavelengths of the relevant modes, a well justified initial state exists, the so-called Bunch-Davies
(BD) vacuum. This is precisely the initial state commonly adopted in general relativity (GR) at the very beginning of the slow-roll inflation,
in which all the relevant perturbation modes are well inside the comoving Hubble radius.

However, in LQC/mLQCs, especially when near the quantum bounce, the evolution of the background is far from "slow", and its geometry
is also far from the de Sitter. In particular, for the perturbations near the bounce, the wavelengths could be larger, equal, or smaller than the
corresponding characteristic scale. Thus, it is in general impossible to assume that the universe is in the BD vacuum at the bounce.
In this talk, we shall consider this important issue within the framework of both the dressed metric and the hybrid approaches. Such conditions
in fact consist of two parts: (a) when to impose, and (b) what initial conditions need to impose consistently. In the literature, two different moments
have been chosen so far in these two approaches: (i) the remote past before the bounce (the contracting phase), and (ii) the bounce. We shall
show in detail that at each moment a consistent choice of the initial conditions depends not only on the specific potential of the inflaton field but
also on the two approaches. In addition, different moments also correspond to different choices of consistent initial conditions.

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