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Early universe cosmology: the no-boundary proposal

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Understanding its origins is one of humanity oldest and most recurrent aspiration. In the latest centuries, physics has enabled us to push further and further this quest for the origins of our universe, resulting in the mid-20th century in the famous theory of the Big Bang and, later, that of inflation.
The Big Bang theory is based on the description of gravitational interaction by General Relativity and is in astonishing concordance with all experimental data collected so far. Nevertheless, there are still huge gaps in our understanding of early phases of the universe. The theory of inflation was one attempt to fill some of these gaps, but it is only partially successful. For example, inflation is quantum incomplete, which means it must still be supplemented by a theory of initial conditions of the universe. Moreover, it has been known for decades that General Relativity is not compatible with quantum theory. But describing the very beginning of the universe would precisely require those two theories to merge in what would be a theory of quantum gravity.
The no-boundary proposal is a theory of the initial conditions of the universe, i.e. it is precisely describing the early quantum phase that would have taken place before the inflationary phase. It is formulated in semi-classical gravity, i.e. a first approximation to quantum gravity in the limit where we recover a classical behaviour. It relies on the existence of regular solutions of the equations of motions and has been recently put on firm theoretical grounds within the framework of General Relativity. Since we know General Relativity is not the end of the story, it is crucial to know whether this no-boundary proposal will still be a solution to the equations of motion for theories involving quantum corrections to General Relativity. Even if we don't know the form of this would-be Quantum Gravity, we can already try to see how the no-boundary proposal applies to several candidates like string theory.
In our work we have shown by explicit computation that regular no-boundary solutions are modified, but not destroyed, upon inclusion of expected quantum gravity corrections and illustrated our results with examples drawn from string theory. These calculations provide a crucial self-consistency test of the no-boundary framework.

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