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The tunneling wavefunction in Kantowski-Sachs quantum cosmology

We use a path-integral approach to study the tunneling wave function in quantum cosmology with spatial topology S1×S2 and positive cosmological constant (the Kantowski-Sachs model). If the initial scale factors of both S1 and S2 are set equal to zero, the wave function describes (semiclassically) a universe originating at a singularity. This may be interpreted as indicating that an S1×S2 universe cannot nucleate out of nothing in a non-singular way. Here we explore an alternative suggestion by Halliwell and Louko that creation from nothing corresponds in this model to setting the initial volume to zero. We find that the only acceptable version of this proposal is to fix the radius of S1 to zero, supplementing this with the condition of smooth closure (absence of a conical singularity). The resulting wave function predicts an inflating universe of high anisotropy, which however becomes locally isotropic at late times. Unlike the de Sitter model, the total nucleation probability is not exponentially suppressed, unless a Gauss-Bonnet term is added to the action.

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