Analytical solutions of the Wheeler-DeWitte equation in the big rip scenario

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In the present work we investigate how the phantom class of dark energy, presumably responsible for a super-accelerated cosmic expansion and here described by the state parameter $\omega = -5/3$, influences the wave function of the Universe. This is done by analytically solving the Wheeler-DeWitt (WdW) equation in the cosmology of Friedmann-Robertson-Walker with an ambiguity term arising from the ordering of the conjugate operators associated with the scale factor a. Its solutions depend on an additional parameter q related to that ordering and show that the Universe presents maximal probability to come into existence with a well-defined size for $q = 0$. The amplitude of the wavefunction is higher the higher is the phantom energy content so an initial singularity of the type $a = 0$ is very unlikely. In this semi-classical approach we also study how the scale factor evolves with time via the Hamilton-Jacobi equation assuming a flat Universe. We show that the ultimate big rip singularity emerges explicitly from our solutions predicting a dramatic end where the Universe reaches an infinite scale factor in a finite cosmological time. Next, we solve the WdW equation with ordinary dark energy related to a positive cosmological constant. In this case, we show that the Universe does not rip apart in a finite era.