A spontaneous creation from nothing for a quantum cosmological model

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Resumo

General relativity (GR) has been widely used to describe the gravitational interaction between the material contents of the Universe. Although GR describes well the dynamical evolution of the Universe by means of a scale factor $a(t)$, it fails to explain its birth when $a(0) = 0$. Then, we have the problem of the initial big bang singularity. In the present work, we will introduce the concepts of quantum mechanics in cosmology in order to study the Universe as a quantum mechanical system. This theory is called quantum cosmology (QC). With the objective of studying the birth of the Universe, we are going to propose a cosmological model which has the Friedmann–Lemaître–Robertson–Walker (FLRW) metric, with plane spatial sections $(k = 0)$. The material content of the model will consist of a perfect fluid of radiation, a positive cosmological constant and an ad hoc potential whose nature is believed to be purely geometric. This ad hoc potential will produce a potential barrier, independent of the value of k. We will show that the wavefunction of this model tunnels that potential barrier. Therefore, we will have an example of the spontaneous creation from nothing mechanism for the Universe. This means that the universe is born in a non-singular way due to its finite size. We will canonically quantize the proposed Universe model and solve the Wheeler-DeWitt equation using the WKB approximation method. Thus, we will obtain the WKB Tunneling Probability of the Universe for different values of the radiation energy (E), the cosmological constant (Λ) and of the ad hoc potential parameter (σ). Finally, we will compare the obtained results

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