Summary: When the scale factor of expansion of the universe is written as $a(t) \equiv A e^{\alpha(t)}$, with $A$ as some real constant and $\alpha(t)$ a real function, the gravitational action $I_G$ appears in the same form as the matter action $I_M$ for a homogeneous and isotropic scalar field with a specific scale factor-dependent potential. We observe that by making analytic continuation of the Lagrangian function in this $I_G$ to the complex plane of $\alpha$, one can obtain terms corresponding to both parts of a total action that describes a viable cosmological model. The solution gives a bouncing and coasting universe, which first contracts and then expands linearly, with a smooth bounce in between them. Such a bounce, called a Tolman wormhole, is due to a Casimir-like negative energy that appears naturally in the solution. In a novel approach to quantum cosmology, we perform canonical quantization of the above model using the operator method and show that it can circumvent the operator ordering ambiguity in the conventional formalism. It leads to a quantum wave equation for the universe, solving which we get the interesting result that the universe is in a ground state with nonzero energy. This solution is different from the Wheeler-DeWitt wave function and possesses exact quantum-classical correspondence during all epochs.

MSC:

83F05 Relativistic cosmology
81P20 Stochastic mechanics (including stochastic electrodynamics)
81P05 General and philosophical questions in quantum theory
81Q65 Alternative quantum mechanics (including hidden variables, etc.)

Keywords:
cosmological models; coasting evolution; bouncing universe; quantum cosmology; quantum-classical correspondence

Full Text: DOI

References:
