QUANTUM UNIVERSE ON EXTREMELY SMALL SPACE-TIME SCALES

V.E. Kuzmichev, V.V. Kuzmichev

Bogolyubov Institute for Theoretical Physics,
Nat. Acad. of Sci. of Ukraine
(*14b, Metrolohichna Str., Kyiv 03680, Ukraine*)

S u m m a r y

The semiclassical approach to the quantum geometrodynamical model is used for the description of the properties of the Universe on extremely small space-time scales. Under this approach, the matter in the Universe has two components of the quantum nature which behave as antigravitating fluids. The first component does not vanish in the limit $\hbar \rightarrow 0$ and can be associated with dark energy. The second component is described by an extremely rigid equation of state and goes to zero after the transition to large space-time scales. On small space-time scales, this quantum correction turns out to be significant. It determines the geometry of the Universe near the initial cosmological singularity point. This geometry is conformal to a unit four-sphere embedded in a five-dimensional Euclidean flat space. During the consequent expansion of the Universe, when reaching the post-Planck era, the geometry of the Universe changes into that conformal to a unit four-hyperboloid in a five-dimensional Lorentz-signatured flat space. This agrees with the hypothesis about the possible change of geometry after the origin of the expanding Universe from the region near the initial singularity point. The origin of the Universe can be interpreted as a quantum transition of the system from a region in the phase space forbidden for the classical motion, but where a trajectory in imaginary time exists, into a region, where the equations of motion have the solution which describes the evolution of the Universe in real time. Near the boundary between two regions, from the side of real time, the Universe undergoes almost an exponential expansion which passes smoothly into the expansion under the action of radiation dominating over matter which is described by the standard cosmological model.