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On de Sitter Universe

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Abstract

In this letter, I address the model which stems from the de Sitter space-time. We can consider empty de Sitter space-time as the Universe where space metrics i.e. the expansion of space is a consequence of the decrease of time elongation during the evolution of Universe i.e. curved time. In the de Sitter metric, this is represented by the relation distance-time elongation and by the acceleration of the expansion of space. The new model explains that de Sitter cosmological time is proper time of the Universe. The cosmological time curvature interacts with photon's energy from distant galaxies like in classical gravitational redshift. Empty de Sitter represents the inertial state of the Universe. What this proposal contributes to the de Sitter universe is variable cosmological constant i.e. parameter. The cosmological parameter is represented in the change of time curvature which we can correlate to the change of photons' energy of distant galaxies and CMBR in time.

Keywords: de Sitter space-time; Curved time; Dark energy; de Sitter effect

Introduction

In this letter, I address the model which stems from the de Sitter space-time. We can consider empty de Sitter space-time as the Universe where space metrics i.e. the expansion of space is a consequence of the decrease of time elongation during the evolution of the Universe. When we have the change of space metrics, the time always changes its metrics (pace) e.g. cosmological time dilation [1]. The change in space metrics and time metrics is always bound by the speed of light. When space contracts, the time dilates, and vice versa, when time contracts, space dilates. Objects accelerate in the gravity field near the mass-energy object mostly due to the curved time; in the new model, the space of the Universe expands in accelerated rate because of curved time. The decrease in time elongation i.e. time contraction which increases during the evolution of the Universe causes the expansion i.e. dilatation of space to increase in time. In de Sitter metric this is represented by the relation distance-time elongation, and by the acceleration of the expansion of space. The new model explains that de Sitter cosmological time is the proper time. Second is always second.

The relation between space and time metrics in de Sitter empty space-time is set by the change between the two so that we have constant space-time curvature, i.e. that the Hubble constant is equal through all time. From this, we can conclude that

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constant space-time curvature i.e. lambda in de Sitter Universe correlates with the Hubble constant. From cosmological observations of our Universe, the Hubble constant i.e. parameter was higher in the past, therefore implying the larger lambda. By the new model, the Hubble parameter will be larger in the future compared with its current value. In the new model, a lambda can have high value like phantom energy without tearing up space (Big Rip). Einstein's Mollusk can contract the time and expand the space (while both staying bound by the speed of light) indefinitely because it is Gaussian.

The aforementioned relation between the Hubble parameter, the dark energy, and scalar curvature has been addressed in many papers which are summed up in the review [2].

The curvature of time increases in the proposed model in the future because the pace of time is becoming much faster, which we already do have in the standard cosmological model represented by the decrease of cosmological time dilatation during the evolution of Universe. De Sitter special relativity in referred paper “de Sitter-invariant special relativity and the dark energy problem” [3] implies when no matter is present, energy density vanishes and lambda vanishes as well, but it is special relativity. In de Sitter Universe and general relativity, it is shown that empty space-time does not preclude Universe expansion and acceleration. As I have mentioned earlier [1], the loss of energy of a photon from distant galaxies correlates with the strength of space-time curvature tensor, and in the far future photons' energy decrease will be even stronger because of large acceleration of space metrics caused by a large decrease in time elongation of our Universe. Space and time are always bound by the speed of light. The time is becoming again more curved, as it was in the beginning, despite the further decrease of matter-energy density. It is simply a property of time.

I agree with statement of Araujo et al. [3] but with the emphasis that empty spacetime does have energy and it is predetermined to have accelerated expansion because of the relation between space and time metrics bound by the speed of light c: "For example, considering that Λ depends directly on the energy density of the universe, it might have assumed a huge value immediately after the big bang [2], which could account for inflation. Subsequently, it decayed together with the energy density of the universe, its current value is determined by the current energy density. Of course, to assess all properties of the theory, as well as the details of the ensuing cosmological model, the relativistic Friedmann equations for the de Sitter-modified Einstein equation should be obtained and studied."

Imagine two small stationary mass particles in classical de Sitter. The two particles will diverge exponentially as space expands. Their stationary mass points travel by curved radius which represents the curvature of time of de Sitter Universe. In the new model, this curvature is proportional to the loss of the energy of a photon from distant galaxies caused both by a change in space and time metrics (alike de Sitter effect) [4]. The cosmological time curvature interacts with photon's energy like in classical gravitational redshift [1]. Similarly to the gravitational shift near the mass-energy object, the transverse i.e. space curvature of Universe which corresponds to matter-energy content (Ω) will also influence the time curvature of Universe but we need to decouple these two effects. Empty de Sitter is an inertial state of the Universe. What this proposal contributes to the de Sitter universe is variable cosmological constant i.e. parameter. The cosmological parameter is represented in the change of time curvature which we can correlate to the change of photons' energy of distant galaxies and CMBR in time. We do not need to call cosmological parameter (lambda) the dark energy because to every space point we do attribute the time, so it can explain why the so-called dark energy permeates everything. It is a curved time.

This could be a step forward to concordance models of physical cosmology by equating quintessence and curved time. The aether of Quinta essentia becomes the geometry of general relativity [5]. This geometry is free from singularities in the past like in classical de Sitter and it is free from future singularities of black holes because of high future quintessence/intrinsic

directional change of time curvature. This Universe does not have asymmetry of the radius of time curvature as quantitative characteristics in the far past and the far future. But this radius is qualitatively different because in the past the time curvature is caused by enormous time dilatation, while in the future the time curvature will be caused by enormous time contraction. Space only has to be highly contracted in the past and enormously expanded in the future, and not bound by its curvature (flat, open, closed), although the preferred notion of the time prefers closed slicing of de Sitter space-time.

De Sitter spacetime metric can be considered as a static metric because there is no preferred notion of time. This approach shows how it can have that notion. What is needed to prove this model is non-static i.e. time-dependent spacetime curvature of empty de Sitter metric from Einstein field equations.

Today's observations of the Universe are saying that we most probably do live in non-empty de Sitter Universe, where time does not have beginning, nor end. Final prove of it would be the victory and the real grandiosity of General Relativity. There are no singularities, no beginning, and no end. Everything is continuous and smooth. It is a simple and beautiful spacetime.

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