Entropy and Distribution of Information in the History of the Cosmos

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Abstract: Here, applying the Scale-Symmetric Theory (SST), we described the origin of entropy and information and their evolution in time in the Cosmos as a whole (the Cosmos has radius about 30 powers of ten of meters i.e. is much greater than the present-day radius of the expanding Universe). On the lowest level of Nature, the global information depends on distribution of rotational and kinetic energies and orientation of the infinitesimal spins of all free and bound non-gravitating tachyons all objects in the Cosmos consist of. The field composed of the free tachyons is the Higgs field - this field causes that neutrinos acquire their gravitational mass. During the inflation, almost whole Higgs field transformed into the luminal gravitating Einstein spacetime that ground state consists of the non-rotating-spin neutrino-antineutrino pairs interacting gravitationally only. Orientation of spin is not important in gravitational field so all such pairs are in the same energetic state i.e. entropy of the ground state is equal to zero and this state dominates in the Cosmos. Moreover, the tachyonic energy frozen inside the neutrino-antineutrino pairs (it is the missing energy that results from quantum physics) is about 119 powers of ten times higher than their gravitational energy. The SST and the Kasner solution (which concerns the non-gravitating objects) show that there is a left-handedness of the residual Higgs field. The collapse of the outer shell of the Einstein spacetime at the end of the inflation created the returning shock wave. The shock wave plus the left-handedness of the residual Higgs field produced more matter than antimatter - it solves the matter-antimatter asymmetry. The returning energy-matter wave created the Universe in the centre of the Cosmos. Due to the boundary of the Cosmos, the Universe behaves cyclically. We start from the era before the inflation and via the inflation and via the neutron-black-holes state of the early Universe and via the present-day, we finish the description in the distant future. The tachyons cause that information cannot be destroyed by the SST black holes - the same concerns the energies of photons in gravitational fields. Entropy of the initial state of the inflation field and of the SST black holes is equal to zero. We can define time as the succeeding changes in the global information. In an approximation, Information behaves cyclically. In the Cosmos as a whole, entropy per particle is infinitesimal whereas total energy is conserved.

Introduction and motivation

The Scale-Symmetric Theory (SST) shows that the succeeding phase transitions of the superluminal non-gravitating Higgs field during its inflation (the initial big bang) lead to the different scales of sizes/energies [1A]. Due to a few new symmetries, there consequently appear the superluminal binary systems of closed strings (entanglons) responsible for the quantum entanglement (it is the quantum-entanglement scale), stable neutrinos and luminal neutrino-antineutrino pairs which are the components of the luminal gravitating Einstein spacetime (it is the Planck scale), cores of baryons (it is the electric-charge scale), and the cosmic-structures/protoworlds (it is the cosmological scale) that evolution leads to the dark-matter structures (they are the loops and filaments composed of entangled non-rotating-spin neutrino-antineutrino pairs), dark energy (it consists of the additional non-rotating-spin neutrino-antineutrino pairs interacting gravitationally only) and expanding universes (the "soft" big bangs due to the inflows of the dark energy into protoworlds) [1A], [1B]. The electric-charge scale leads to the atom-like structure of baryons [1A].

According to SST, the inflation started due to collision of a non-gravitating but inertial (so it is beyond the General Theory of Relativity (GR)), rotating (it had left-handed external helicity), superluminal big piece of space (its speed in the truly-vacuum/nothingness was about 10^{97} m/s) composed of very small pieces of space (size about 10^{-64} m) being in the rest in co-moving frame of reference, with much bigger and much slower piece of space composed of smaller parts as well [1A], [1B]. Global information carried by the first big piece of space, i.e. information that at least partially can be transferred to other bodies, is coded in the inertial rotational and kinetic energies of it.

Due to the collision, the global rotational and kinetic energy of the first big piece transformed, inside the much bigger second piece of space, into the thermal and rotational energies of the tachyons. The second big piece of space transformed into the boundary of our Cosmos with inner radius $2.3 \cdot 10^{30}$ m [1B]. The Kasner solution that concerns the non-gravitating objects leads to conclusion that the tachyonic gas as a whole should have a residual left-handedness (a cosmic torus with left-handed internal helicity i.e. there should be residual toroidal and poloidal motions of the Higgs field). Such transformation started the inflation.

At the very beginning, the inflation field was composed of tachyons packed to maximum so distribution of tachyons was perfect and we can assume that all tachyons were in the same energetic state i.e. there was only one microstate i.e. each microstate was equally likely. It leads to conclusion that the thermodynamic entropy of such state of the Higgs field, S, was equal to zero ($W = 1$)

$$S = k_B \, ln \, (W), \tag{1}$$

where k_B is the Boltzmann constant whereas W is the number of microstates (various combinations of particles in various energy states). In such state, the global information is coded in the (inertial only) rotational and kinetic energies of the tachyons. Orientation of spin is not important in gravitational field so all the neutrino-antineutrino pairs in the ground state of the Einstein spacetime have the same energetic state so its entropy is equal to zero as well – moreover, this entropy dominates in the Cosmos.

The phase transitions of the expanding Higgs-field/inflation-field stopped the inflation [1A], [1B], [2]. The inflation ended because majority of the initial superluminal Higgs field transformed into the gravitating luminal Einstein spacetime in such a way that on its surface, the gravitational pressure became higher than the dynamic pressure. On the other hand, the

boundary of our Cosmos is the boundary for the residual Higgs field. Due to the interactions of the residual Higgs field with the neutrinos, the neutrinos acquire their gravitational mass [1A]. Moreover, the tachyonic energy frozen inside the neutrino-antineutrino pairs (it is the missing energy that results from quantum physics) is about $0.6 \cdot 10^{119}$ times higher than their gravitational energy [1B].

The SST and the Kasner solution (which concerns the non-gravitating objects) show that there is a left-handedness of the residual Higgs field [1C]. The collapse of the outer shell of the Einstein spacetime at the end of the inflation [1B] created the returning shock wave.

The shock wave plus the left-handedness of the residual Higgs field produced more matter than antimatter - it solves the matter-antimatter asymmetry. The returning energy-matter wave created the Universe in the centre of the Cosmos. Due to the boundary of the Cosmos, the Universe behaves cyclically.

According to SST, all objects in the Cosmos [1B], besides the free tachyons) consist of the bound tachyons. The bound tachyons interact (due to the dynamic viscosity) with the free tachyons the residual Higgs field consists of. The closed strings in the neutrinos have internal helicity so neutrinos transform the thermal motions of free tachyons into their divergent motions. Collisions of the divergently moving tachyons with the thermal tachyons produce gradient around each stable neutrino in the residual Higgs field – it is the gravitational field i.e. gravitational field is composed of non-gravitating tachyons [1A]. Since inertial mass density of the residual Higgs field is much lower (about $4 \cdot 10^{42}$ times) than the gravitating Einstein spacetime, which is associated with the Standard-Model (SM) interactions, then gravity is much, much weaker than electromagnetism, nuclear weak interactions and nuclear strong interactions. Spins of the SM particles can rotate so rotational energy of a bound tachyon in a rotating-spin SM particle is divided into parts associated with rotation of the closed strings, with rotation of the neutrinos or neutrino-antineutrino pairs, with rotation of, for example, electron, and so on. We can see that today the global information depends on distribution of all free and bound tachyons and distribution of their energies among moving and rotating objects.

According to SST, the early Universe consisted of protogalaxies composed of the neutron black holes (NBHs) [1B]. In such NBHs is an orbit with spin speed equal to the speed of light in "vacuum" but there is no singularity [1B]. Moreover, due to the big number of neutrons and binding energy frozen inside the NBHs, they behave as if they interacted gravitationally only i.e. classically – such interaction is beyond SM so practically all neutrons in a NBH can be in the same microstate – each NBH is the sphere with parallel spins of all neutrons.

It leads to conclusion that the thermodynamic entropy of the SST black holes is equal to zero. Due to the tachyons interacting with the SST black holes and due to the flows in the Einstein spacetime, even from the accretion disc to jet [3], the SST black holes do not destroy information.

According to SST, the photons are the rotational energies of the free or entangled neutrino-antineutrino pairs so we can say that they are the massless objects but the carriers of them have mass. It means that the carriers of photons can interact with gravitational fields i.e. there can be transfer of rotational energy between photon and gravitational field – it leads to conclusion that gravitational redshift does not cause that energy disappears [4]. Just gravity is non-local as well.

The inflation was the irreversible process so the Cosmos cannot return to the initial state of the Higgs field. Moreover, gravity and other interactions cause that distribution of free and

bound tachyons changes in time and changes distribution of their rotational and kinetic energies and orientation of their infinitesimal spins. It leads to conclusion that global information changes in time so time is going.

We can define time as the succeeding changes in the global information.

We wrote that at the end of the inflation, due to the collapse of the outer shell of the Einstein spacetime [1B], there in the Cosmos appeared the energy-matter returning wave – due to the residual left-handedness of the residual Higgs field, the returning wave created the left-handed Protoworld in the centre of our Cosmos. The evolution of Protoworld causes that there appears the expanding dark energy that after reflection from the boundary of the Einstein spacetime [1B] creates new returning wave that creates new left-handed protoworld in the centre of our Cosmos, and so on.

Due to the returning wave created at the end of the inflation and due to the succeeding expansions and collapses of the dark energy and matter, our Universe is cyclic with period about $5 \cdot 10^5$ Gyr [5]. There is very high probability that the observed expansion of the Universe is not the first. It suggests that in an approximation, when we start our considerations from creation of the first universe, the global information behaves cyclically as well.

Due to the boundary of the Cosmos, the total energy is conserved.

In the Cosmos dominates the Einstein spacetime so entropy per neutrino-antineutrino pair is infinitesimal.

Due to the internal helicity of the residual Higgs field, there is more matter than antimatter – just internal helicity distinguish particles from antiparticles [1A].

References
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