

Real and Imaginary Time and Evolutions of Thermodynamic Time in the Scale-Symmetric Theory

Sylwester Kornowski

Abstract: The modern conception of time is based on the General Theory of Relativity (GR). The GR gravitational time is associated with the escape velocity i.e. concerns the radial motions of masses/energies in gravitational fields. The two-component grainy spacetime described within the Scale-Symmetric Theory (SST), i.e. the non-gravitating superluminal Higgs field (HF) concerning the gravitational fields and the gravitating Einstein spacetime (ES) composed of the neutrino-antineutrino pairs moving with the speed of light in “vacuum” (which leads to the Standard Model interactions), causes that the SST time for the ES components in ground state (the gravitational interactions only) and for baryonic plasma (BP) near black holes is neither Einsteinian nor Newtonian. Here we described the SST time in the absence and in the presence of BP. The SST time does not concern the GR time associated with not granular spacetime. But it does not mean that the GR time, which concerns objects that can change their speed, is incorrect. Just GR is the incomplete theory (the speed of the ES components is invariant) so it incorrectly describes dynamics of black holes (BHs). The SST time is characteristic for flows of the ES forced by gravitational fields and for flows of BP forced by flows of the dark-matter (DM) structures, especially near and inside the SST BHs. Here we derived the formulae for the ES and BP gravitational time dilation, we explained what is imaginary time, we described the difference between the HF and ES thermodynamic time, and we present how have changed the thermodynamic units of time during the evolution of the Cosmos. Contrary to the GR BHs, due to the DM structures produced by BP on surfaces of the SST BHs and the invariance of speed of the ES components, particles can escape from the SST BHs via the jets.

1. Introduction

The Scale-Symmetric Theory (SST) shows that the succeeding phase transitions of the superluminal non-gravitating Higgs field (HF) (they are the topological phase transitions) 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), neutrinos and neutrino-antineutrino pairs moving with the speed of light in “vacuum” which are the components of the gravitating Einstein spacetime (ES) (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 (DM) 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 the expanding Universe (the “soft” big bang due to the inflows of the dark energy into Protoworld) [1A], [1B]. The electric-charge scale leads to the atom-like structure of baryons [1A].

According to SST, the very early Universe was the cosmic double loop composed of rotating protogalaxies built of the neutron black holes (NBHs) [1B]. The DM structures are not a part of the ES but the ordered motions in them decrease local pressure so there are inflows of the ES to equalize the dynamic pressure. By using other words we can say that rotating baryonic plasma (BP) produces the DM loops from the ES components. This process decreases local dynamic pressure – it forces the inflows of the ES components to equalize the pressure. In such a way, the DM structures acquire their mass – for example, DM rings in the ES are some analog to, for example, iron rings in liquid iron but density of the DM rings can be higher, equal to, or lower than the ES.

SST shows that during the inflation (it was due to the collision of two big pieces of space [1A], [1B]), almost whole HF transformed irreversibly into ES – it is the cause that gravitational interactions, which are associated with HF, are about $4 \cdot 10^{42}$ times weaker than the electromagnetic interactions which are associated with ES.

SST shows as well that mass of the neutrino-antineutrino pairs [2] and their speed [1A] (it is the speed of light in “vacuum” c) are the invariants. It leads to conclusion that in the ground state of the ES (then the non-rotating-spin components interact gravitationally only), kinetic energy of the neutrino-antineutrino pairs is invariant and is $E_{kin} = 2 m_{neutrino} c^2 = const.$.

The non-gravitating tachyons the gravitational fields consist of are moving with speed about $8 \cdot 10^{88}$ times higher than the c [1A]. It causes that the lines of gravitational forces are the straight lines even for masses with equatorial spin speed close to c .

The SST neutron black holes (more massive SST black holes (BHs) are built of NBHs [1B]) have regions with mass density of the carriers of gluons (i.e. of the neutrino-antineutrino pairs) much higher than the density of the ES [1A]. It causes that angular momentums of the NBHs and the ES inside them are the same i.e. the NBHs are in the rest in relation to the rotating region of ES. It means that they have the spherical symmetry and that spin speed of neutrons on the equators of the NBHs for a distant observer is c .

2. Flows of the Einstein spacetime forced by gravitational fields of the NBHs the SST BHs consist of in the absence of baryonic-plasma/accretion-disc

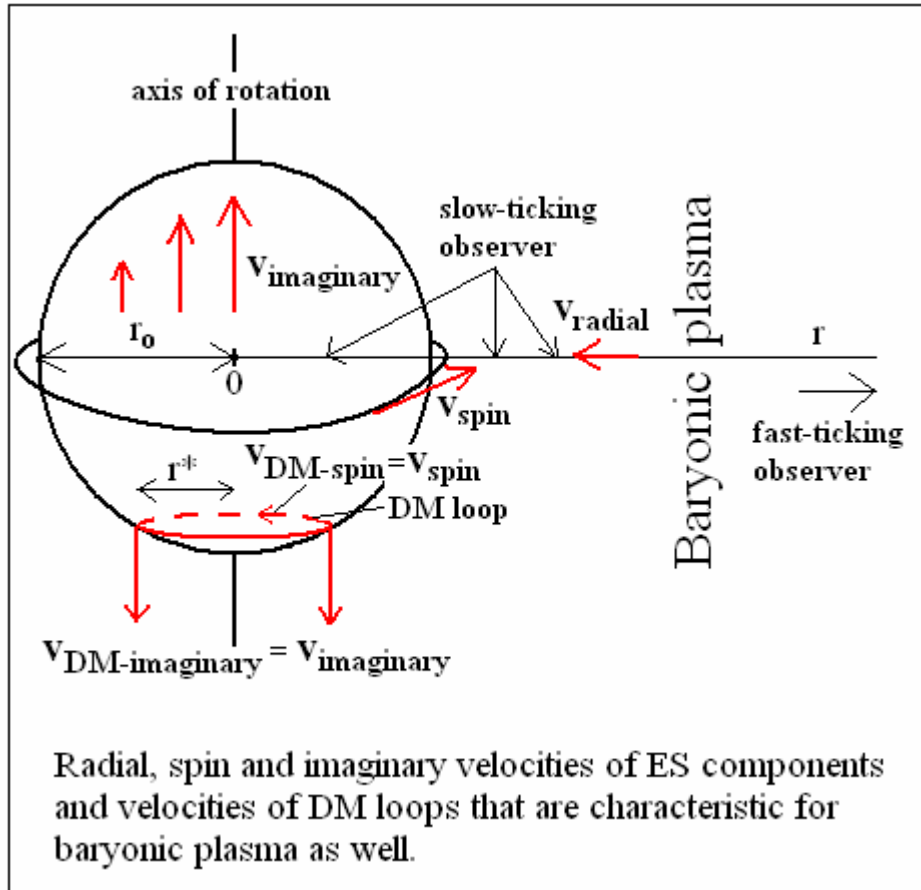
Due to the two-component SST spacetime, in GR very frequently gravitational fields, which are associated with Higgs field, are confused with electromagnetic fields which are associated with Einstein spacetime. It causes that, for example, there appear nonexistent gravitational waves which in reality are the periodically changing flows in the Einstein spacetime [3]. The properties of the two-component spacetime cause that we obtain a different formula for the gravitational time dilation for ES than the derived from the Schwarzschild metric. But it does not mean that the GR time, which concerns objects that can change their speed, is incorrect. Just GR is the incomplete theory (the speed of the ES components is invariant) so it incorrectly describes dynamics of black holes.

Consider a SST non-rotating-spin neutrino-antineutrino pair moving towards a rotating SST NBH along a radius in the plane of its equator. ES is grainy and gravitating so gravitational field of the NBH causes that in ES appear spin speeds as well. Such rotation, due to the regions in NBH with much higher density than ES, forces rotation of the NBH i.e. each NBH

must rotate. Invariance of kinetic energy of the ES components causes that at the GR Schwarzschild distance $r_s = 2 G M / c^2$, the pair crosses sphere with such a radius at an angle of 45° (the spin speed and radial speed both are $c / (2)^{1/2}$). In distance $r_o = G M / c^2$, the spin speed is c so radial speed is zero i.e. there appears the equator with the spin speed equal to c . But it is an illusory singularity because dynamic pressure in the ES is tremendous ($\sim 10^{45}$ Pa [1A]) so the ES components are pushed into the interior of the NBH. Emphasize that the photons and gluons are the rotational energies of the ES components – their different properties follow from different behaviour in fields with and without internal helicity [1A]. Inside NBH, the spin speed is directly proportional to distance from the axis of rotation whereas radial motions, because of the dynamic pressure, are infinitesimal so we can neglect them. It forces the motions of the neutrino-antineutrino pairs in directions perpendicular to the plane defined by the inspiralling pairs. The perpendicular motions define the imaginary time because imaginary directions are perpendicular to the real directions associated with the motions in the equatorial plane (observer is placed on the real plane)

$$e^{i\pi/2} = \cos(\pi/2) + i \sin(\pi/2) = i = (-1)^{1/2} \quad (1)$$

i.e. for angle $\pi/2$ rad = 90° we obtain i .



In reality, imaginary time is real whereas $i = (-1)^{1/2}$ is used to describe the perpendicular motions in relation to the real motions – just it is a mathematical trick. Notice that outside NBH, the imaginary motions are forced only because of the very high dynamic pressure in ES, not by rotating spacetime as it is inside NBH – it causes that such mechanism cannot lead to a collimated jet. But we will show that the superposition of the imaginary motions on

surface of NBH and creation of DM loops by inspiralling baryonic plasma leads to the emergence of collimated jet along the axis of rotation – such jet is composed of moving DM loops and of carried by them baryonic plasma and ES components.

Following formula is valid for an ES component moving in the plane of equator of NBH and inside NBH in the absence of baryonic-plasma/accretion-disc

$$c^2 = v_{radial}^2 + v_{spin}^2 + v_{imaginary}^2. \quad (2)$$

For $r > r_o = GM/c^2$ is $v_{imaginary} \approx 0$ whereas $v_{spin}^2 = GM/r$.

For $r \leq r_o$ is $v_{radial} \approx 0$ whereas $v_{spin} = cr^*/r$, where r^* is the distance from axis of rotation, not from the centre of NBH.

Notice that due to the ES dynamic pressure, changes in v_{radial} on equator of NBH and near it, but outside it, are a little smaller that it follows from formula (2) so there appear low imaginary velocities as well.

3. Flows of the Einstein spacetime forced by gravitational fields of the NBHs the SST BHs consist of in the presence of baryonic-plasma/accretion-disc

The baryonic plasma accreting on surface of NBH (thickness of the accretion disc can be greater than the size of NBH (size of NBH is ~ 73 km [1B])) produces DM loops overlapping with the parallels of latitude. Their spin speed is $v_{spin} = cr^*/r$ whereas imaginary speed is $v_{imaginary} = (c^2 - v_{spin}^2)^{1/2}$. We can see that the moving succeeding DM loops look as cylinders inside cylinders with axes of rotation overlapping with the axis of rotation of NBH. Such cylinders move along NBH axis. The distances between entangled ES components in the DM loops are the same as in ES so they are non-transparent for baryonic plasma – this means that the DM cylinders carry the baryonic plasma so BP has the same spin velocity and imaginary velocity as the DM cylinders (of course, the BP interacts electromagnetically with electrons). Such is the origin of the collimated jets produced by NBHs. We can see that the jets should carry the ES components as well.

Such mechanism acts all the time so contrary to the GR BHs, due to the DM structures produced by BP on surfaces of the SST NBHs and invariance of the speed of the ES components, particles can escape from the SST NBHs and SST BHs via the jets.

The strong magnetic field produced by the rotating BP additionally stabilizes the jets.

Notice that due to the expansion of the Universe or BP, the distances between the entangled ES components in DM structures can increase. For distances greater than about 1 fm, the DM structures are transparent for BP. But it does not mean that DM and nuclear matter does not interact – there still is valid the DM-BP advection [4].

4. The ES real time

Energy of a non-rotating-spin neutrino-antineutrino pair interacting gravitationally only (the ES ground state) in gravitational field of NBH is the sum of the invariant kinetic energy $E_{kin} = 2 m_{neutrino} c^2 = const.$ and Newtonian potential energy

$$E_{ES} = 2 m_{neutrino} c^2 - GM(2 m_{neutrino})/r. \quad (3a)$$

For $r \geq r_o$ we obtain

$$E_{ES, r \geq GM/(cc)} = 2 m_{neutrino} c^2 [1 - GM/(r c^2)]. \quad (3b)$$

We can see that on the equator of NBH, the total energy of the ES components is equal to zero.

Notice that the GR event horizon does not concern the ground state of ES – it concerns the masses/energies moving in not grainy ES. We proved that along the jets, the GR event horizon is illusory. Moreover, SST shows that due to the irreversible processes during the inflation, the GR singularity for $r = 0$ for the GR BHs does not appear [1A], [1B].

SST shows that due to the very high dynamic pressure in ES, the thickness of the ES slices is invariant ($L \approx 3.9 \cdot 10^{-32}$ m [1A]). It means that ES is flat – curved are the gradients in the Higgs field i.e. curved are the gravitational fields which inertial density is much, much lower – it is the reason that the two-component spacetime as a whole is flat.

Denote by $\Delta\tau_{unit}$ the unit of the proper time (the moving reference frame) for a slow-ticking observer within the gravitational field. Then such unit can be defined as the ratio of the thickness of the ES slices L and the radial speed (formula (2))

$$\Delta\tau_{unit} = L / v_{radial} . \quad (4)$$

Denote by Δt_{unit} the unit of the coordinate time for a fast-ticking observer at an arbitrarily large distance from the massive object. Such unit can be defined as follows

$$\Delta t_{unit} = L / c . \quad (5)$$

From (2), (4) and (5) we obtain

$$\Delta\tau_{unit} = \Delta t_{unit} / [1 - G M / (r c^2)]^{1/2} . \quad (6)$$

For $\Delta t_{unit} = 1$ s for distant observer, we obtain for the NBH equator $\Delta\tau_{unit} \rightarrow \infty$ i.e. unit of time lasts forever – it means that the radial time stops.

Notice that for the ES time, not for units of time, is

$$\tau = t [1 - G M / (r c^2)]^{1/2} . \quad (7)$$

5. The ES imaginary time

The ES imaginary time is characteristic for the interior of the NBH, for the DM cylinders and for the baryonic-plasma jets for an observer placed in distance r^* from the NBH axis of rotation.

For $r^* \leq r_o = G M / c^2$ is

$$v_{radial} \approx 0 \quad (8a)$$

$$c^2 = v_{spin}^2 + v_{imaginary}^2 \quad (8b)$$

$$v_{spin} = c r^* / r_o \quad (8c)$$

$$\Delta\tau_{unit,imaginary} = L / v_{imaginary} \quad (8d)$$

$$\Delta t_{unit,imaginary} = L / c \quad (8e)$$

From formulae (8a) – (8e) we obtain

$$\Delta\tau_{unit,imaginary} = \Delta t_{unit,imaginary} / (1 - r^{*2} / r_o^2)^{1/2}. \quad (9)$$

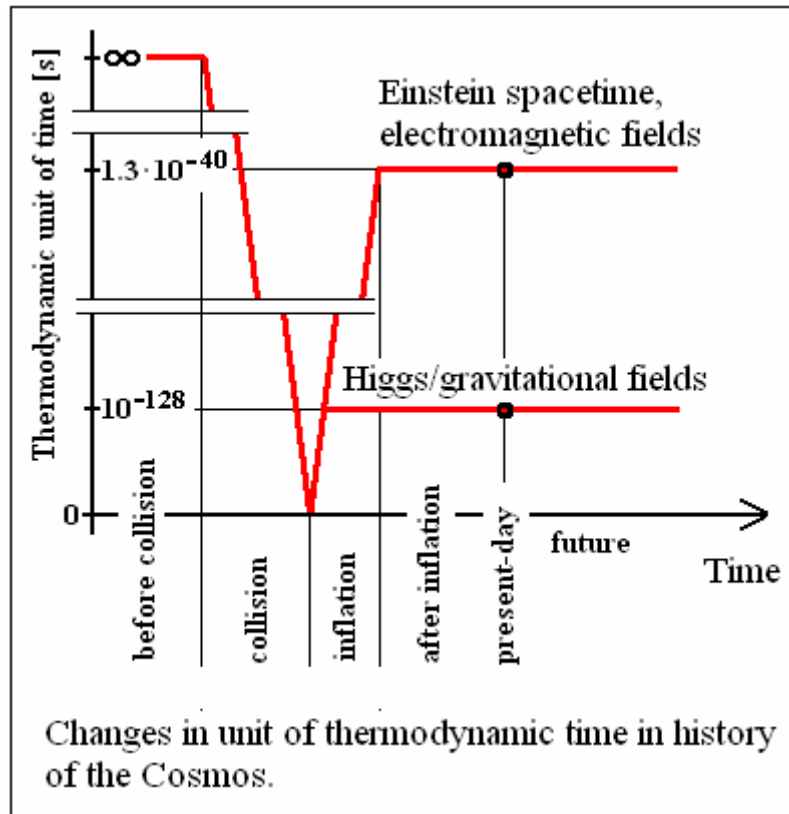
We can see that the imaginary time on axis of rotation is invariant whereas imaginary time stops for $r^* = r_o$.

6. The thermodynamic time for Higgs field and Einstein spacetime and their global evolutions within SST [1A]

The thermodynamic global unit of time we can define as the ratio of mean length of side of cube occupied by one component of a field to its mean speed respectively in Higgs field (it is characteristic for gravitational fields as well) and Einstein spacetime (it is characteristic for electromagnetic fields as well).

On the base of the SST, we can calculate that today the unit of the Higgs-field/gravitational thermodynamic time is about 10^{-128} s (it is the unobservable time because it lasts shorter than the Planck time) whereas the unit of the Einstein-spacetime/electromagnetic thermodynamic time is about $1.3 \cdot 10^{-40}$ s (it is the observable time). The maximum relative change in density of such fields are about 1 part in 10^{20} parts for gravitational fields and about 1 part in 10^{22} parts for electromagnetic fields. For the Higgs field it follows from the ratio of the area of the surface of an entanglon to the area occupied by one entanglon on the torus of neutrino [1A]. For the Einstein spacetime it follows from the changes in density of the ES due to the creations of the electron-positron pairs (the ratio of the density of bare electron to density of ES) [1A].

Such very small changes cause that practically the gravitational constant and the fine-structure constant outside baryonic plasma are the invariants.



7. Summary

GR is the incomplete theory (in reality the ES is grainy, the speed of the ES components is invariant, and the moving baryonic plasma produces the dark-matter structures) so it incorrectly describes dynamics of black holes.

The properties of the two-component spacetime cause that the ES time is neither Einsteinian nor Newtonian.

In the SST of BHs appears the imaginary time that is characteristic for the ES components inside NBHs, for DM loops and baryonic matter inside the jets. It causes that contrary to the GR, particles can escape from the SST NBHs via jets. Of course, there is an abstract Schwarzschild surface for $r_S = 2 G M / c^2$ except for the areas defined by the intersection of the jet with the abstract surface.

In reality, imaginary time is real. The imaginary unit is used to describe the perpendicular motions to the real plane defined by the NBH equator or accretion disc.

The global evolutions of the thermodynamic time depend on changes in densities of the HF and ES. In present-day, such changes are infinitesimal so the gravitational constant and the fine-structure constant outside baryonic plasma are practically the invariants.

We can define the actual state of the Cosmos [1B] as the distribution, orientations of the infinitesimal spins and distribution of the kinetic and rotational energies of all free and bound tachyons – it causes that a journey to the past is impossible unless the state of the Cosmos can change cyclically [5] but such journey cannot be controlled by an apparatus.

According to SST, the gravitational interactions and quantum entanglement are the non-local phenomena so cause and effect do exist on a particle level only when we consider all particles in the Cosmos (a global consideration) – it follows from the fact that local phenomena are not perfectly separated from the rest of the Cosmos.

References

- [1] Sylwester Kornowski (2015). *Scale-Symmetric Theory*
 [1A]: <http://vixra.org/abs/1511.0188> (Particle Physics)
 [1B]: <http://vixra.org/abs/1511.0223v2> (Cosmology)
- [2] Sylwester Kornowski (27 August 2016). “The PMNS Neutrino-Mixing Matrix in the Scale-Symmetric Theory”
<http://vixra.org/abs/1608.0145>
- [3] Sylwester Kornowski (16 March 2016). “The Alternative Interpretation of the LIGO Data”
<http://vixra.org/abs/1602.0177>
- [4] Sylwester Kornowski (19 June 2016). “Interactions of the Dark-Matter Loops with Baryonic Matter Once More”
<http://vixra.org/abs/1606.0191>
- [5] Sylwester Kornowski (4 September 2016). “Entropy and Distribution of Information in the History of the Cosmos”
<http://vixra.org/abs/1609.0008>