



Singularities of Space and Time Around the Big Bang: A Modified Theory for the Beginning of the Universe

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Abstract: Our knowledge about the Big Bang is based on the Standard Model of physics. The Standard Model can describe the history of the universe up to 10^{-43} seconds after the Big Bang, then general relativity and quantum mechanics give contradictory and nonsensical results around the Planck-time. The Hawking-Penrose singularity theorem for the Big Bang set four conditions for the theorem to hold. We will demonstrate in this article that the condition: *Einstein's equations hold*, is not met. Thus, there was no spacetime singularity, neither spatial singularity around the Big Bang. This article presents a modified description of the Big Bang based on a previously published theory for black hole physics, but in this case applying it in the reverse direction: if matter collapses into black holes by leaving time and entropy at the event horizon, then it must have happened the opposite direction after the Big Bang. So, time and entropy emerged after space and gravity already existed. This explains the problems of the Standard Model in describing the first 10^{-43} seconds after the Big Bang: not this 10^{-43} seconds are missing, but time is missing. The theory also explains the problem with the inflation period of the Big Bang, where the inflation speed exceeded the speed of light: as time did not exist during the inflation period, we cannot interpret speed in that epoch. The presented theory is in line with all laws of physics and explains existing unsolved problems of general relativity and quantum mechanics. In this case presented theory explains the missing first epoch of the Big Bang and the problem with the speed of cosmic inflation - before time and entropy emerged together.

Keywords: Big Bang, general relativity, Quantum Mechanics, Einstein spacetime, space and time, Standard Model of Particles

INTRODUCTION

Our knowledge about the Big Bang is based on the Standard Model of physics. The Standard Model can describe the history of the universe up to 10^{-43} seconds after the Big Bang, then general relativity and quantum mechanics give contradictory and nonsensical results around the Planck-time. The Hawking-Penrose singularity theorem for the Big Bang set four conditions for the theorem to hold. We will demonstrate in this article that the condition: *Einstein's equations hold*, is not met. Thus there was no spacetime singularity, neither spatial singularity around the Big Bang.

This article presents a modified description of the Big Bang based on a previously published theory for black hole physics, but in this case applying it in the reverse direction: if matter collapses into black holes by leaving time and entropy at the event horizon, then it must have happened the opposite direction after the Big Bang. So time and entropy emerged after space and gravity already existed. This explains the problems of the Standard Model in describing the first 10^{-43} seconds after the Big Bang: not this 10^{-43} seconds are missing, but time is missing. The theory also explains the problem with the inflation period

of the Big Bang, where the inflation speed exceeded the speed of light: as time did not exist during the inflation period, we cannot interpret speed in that epoch. The presented theory is in line with all laws of physics and explains existing unsolved problems of general relativity and quantum mechanics. In this case presented theory explains the missing first epoch of the Big Bang and the problem with the speed of cosmic inflation - before time and entropy emerged together.

Limitations of General Relativity and Quantum Mechanics around Black Holes and the Big Bang

General relativity [1] and quantum mechanics [2] both break down around the Big Bang. The Standard Model cannot describe the first 10^{-43} seconds after the Big Bang (Planck-time), where general relativity and quantum mechanics give contradictory, nonsensical results for this period.

These nonsensical results emerge from the wrong interpretation of the framework: space-time did not exist from the beginning of the Big Bang, so spacetime cannot be the framework for describing its first period. As described in [4] time stops at the event horizon of black holes and the Big Bang had a similar '*particle phase*' in the opposite expanding direction - defined by gravity, strong force and electric charge - until time emerged.

Not 10^{-43} seconds are missing to be described at the beginning of the Big Bang by the Standard Model, but time is missing as a parameter during the first phase. Time emerged together with entropy after the '*particle phase*' of the Universe.

As space and gravity are related, time and entropy are related (and attached) to each other too. The '*end of time*' at the event horizon and the entropy staying there [4, 5, 6, 7], confirm that entropy and time are close linked and inseparable from each other - in line with the 2nd law of thermodynamics, If there is no time, there is no entropy and if there is no entropy, there is no time. (Details on the time-entropy relation will be given elsewhere.)

This also means that time emerges with entropy after the Big Bang and time ends when entropy ends - or at a Big Crunch for the whole universe or at the event horizon of black holes locally.

The Hawking-Penrose Singularity Theorem around the Big Bang and its Limitations

Stephen Hawking and Roger Penrose described the Big Bang as an event arising from a singularity with infinite density on one single point [3]. The authors set four conditions to be met in order to the theorem to hold:

1. Einstein's equations hold (with zero or negative cosmological constant),
2. The energy density is nowhere less than minus each principal pressure nor less than minus the sum of the three principal pressures (the '*energy condition*'),
3. There are no closed time-like curves,
4. Every time-like or null geodesic enters a region where the curvature is not specially aligned with the geodesic.

The authors correctly set these conditions for the theorem. We will demonstrate that condition (i): *Einstein's equations hold*, is not met around the Big Bang, thus there was no spacetime singularity, neither spatial singularity at beginning of our Universe.

The Minkowski-spacetime breaks down around the Big Bang (described in section 3) and in [4]. This is due to the fact that time did not exist at the beginning of our Universe (described in section 4), so spacetime did not exist either. By applying wrongly the Einstein equations and the Minkowski-spacetime as a framework, the solution was inevitably a spatial and a spacetime singularity and both were wrong. The time-like singularity exists in the phases following phases of the Big Bang, as time starts there with entropy.

Breaking of Space-time Around Black Holes

General relativity implies, that spacetime breaks around black holes. This is right as the 4D Minkowski-spacetime indeed breaks into parts around black holes. As we can observe black holes with the 3 known spatial dimensions and we have gravitational wave observations, we have the proof that spatial dimensions do not disappear. So the only possibility is that spatial dimensions separate from the time dimension at the event horizon.

The time dimension stays at the event horizon as described by general relativity: with an infinite time dilation - time effectively stops at the event horizon. We can say that the time dimension is curved up on event horizon, with the entropy linked to it - providing an explanation to the black hole information paradox as confirmed by three independent theories [5, 6, 7] and in line with one the strongest laws of physics: the 2nd law of thermodynamics (entropy of a closed system can only increase). We will demonstrate in section 4) that we can apply the same logic reversed for the Big Bang: here time does not end, it starts here after the first phases of Big Bang.

In the case of black holes the three spatial dimensions enter the black hole, as spatial and time dimensions separate - so black holes are regions of the Universe with spatial structure, but without time as we know it, as described in Figure. 1.

SPACETIME SEPARATION AROUND BLACK HOLES

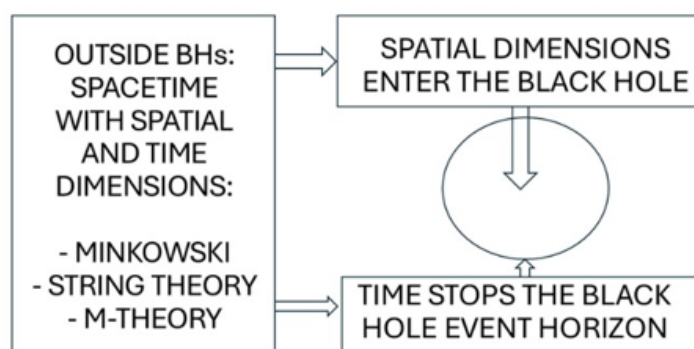


Fig. 1: Separation of spatial and time dimensions at the event horizons of black holes

The reasons of space-time singularities around black holes were identified by Roger Penrose [8] and they are the following:

1. Negative energy occurs,
2. Einstein's equations are violated,
3. The space-time manifold is incomplete,
4. The concept of space-time loses its meaning at very high curvature -possibly because of quantum phenomena,

As explained in [CSEKO 2026] the right answers are (b), (c) and (d).

(b) Einstein's Equations are Violated

Indeed the equation defining the metric of 4D Minkowski-spacetime:

$$ds^2 = -c^2 dt^2 + dx^2 + dy^2 + dz^2$$

when time stops, due to time dilation and disappears, the metric becomes (t=0),:

$$ds^2 = dx^2 + dy^2 + dz^2$$

(c) The Space-time Manifold is Incomplete

As the time dimension disappears, while spatial dimensions continue to exist, indeed the space-time manifold becomes incomplete: it disappears as a manifold.

(d) The Concept of Space-time Loses its Meaning at Very High Curvature - Possibly because of Quantum Phenomena

Indeed, the concept of space-time loses its meaning, as the time dimension disappears. There is only space in the interiors of black holes. The reason being partly quantum phenomena [6], but the also the disappearance of the whole time dimension, also at macro level [4, 7].

As we observe the end of time around black holes at the event horizon, we must pose the question did time emerge around the Big Bang? The answer is yes and it is based on the link between entropy and time, the details are given in section 4.

Reversing the Solution of the Black Hole Information Paradox for the Conditions of the Big Bang

As explained the spacetime breaks into spatial and time dimensions at the event horizon around black holes, and time ends there. In the case of the Big Bang time emerges with entropy after the '*quark-gluon phase*' and '*particle phase*' (see section 5).

The '*particle phase*' of the Big Bang resembles the interiors of black holes, as only particles (electrons and protons) exist, without wave function. This is a phase of the Big Bang before time started. The difference is that while black holes are result of gravitational collapse, the Big Bang is the opposite: an expansion. Both processes can be modelled as spherically symmetric ones.

So during the Big Bang the second '*particle phase*' is dominated by gravity, electric charge and the strong force. We could call it the '*black hole phase*' of the expanding Universe - even if it was temporary state of the matter. It is surrounded by an '*event horizon*' where entropy and time start. The emergence of time and entropy after space is presented on Figure 2.

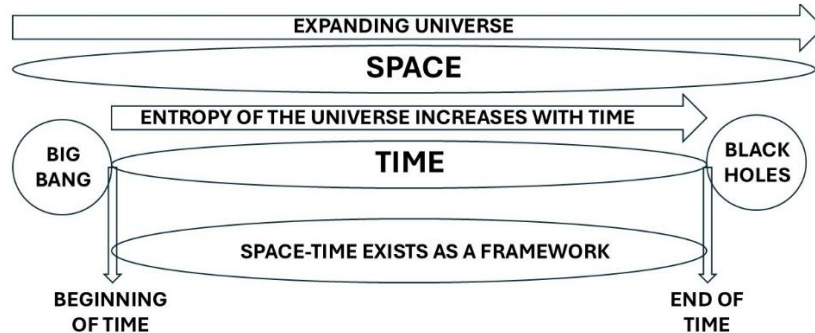


Figure 2: The emergence of space, entropy and time in the universe

Time exists throughout most of the history of the universe except the first phases of the Big Bang, where it emerges with entropy after the first '*quark-gluon phase*' and '*particle phase*'.

This is also in line with the conditions set by Hawking and Penrose [3]. The condition which is not met, is again:

- *The Einstein's equations do not hold*, as there is no time, there is no spacetime (as described in section 3).

Consequences:

1. *Time will always be one-directional*: it moves to one direction with the increase of entropy - in line with the 2nd law of thermodynamics.
2. *As entropy cannot decrease, time cannot go backwards*. This is the reason why time-travel cannot exist and the theories about negative time (time going backwards) are based on a wrong interpretation of space-time in the universe and specifically around black holes [4].
3. The theory resolves the problem of the Standard Model with the cosmic inflation speed - exceeding the speed of light - and the description of the first 10^{-43} seconds of the Big Bang: as there was no entropy and time, space-time did not exist and cannot be used as a reference framework.
4. The local gravitational collapse can result in breaking of spacetime and time locally stopping around the event horizon [4]. Within the universe many time-less zones exist: black holes surrounded by their event horizons.
5. There is no spatial singularity of the Big Bang starting from one single point. Instead we may calculate the size of the core zone of the Universe made of quark-gluon plasma (see section 6).

A Modified Description of the Big Bang

In this description we identify three phases of the Big Bang based on existence of time and entropy: the first two phases ('quark-gluon phase' and 'particle phase') have no time, neither entropy. Therefore space-time does not exist as a framework.

The third 'wave-particle phase' is when time and entropy emerge and space-time does exist as a framework. This is the phase described by the Standard Model based on general relativity and quantum mechanics with all known particles and forces present.

1. The first 'quark-gluon phase' is described by the quark-gluon plasma: quarks and gluons forming a hot plasma with a temperature between 2×10^{12} °K and $5,5 \times 10^{12}$ °K. Protons and electrons are not yet formed. Gravity exists, but strong force is not there yet. Electric charge does not exist.

Time does not exist.

This epoch is the 'quark-gluon phase' of the Universe. A state described by only gravity and quarks and gluons. A timeless, hot plasma.

2. The second 'particle phase' is where protons and electrons are formed from quarks, as the strong force emerges. Gravity continues to exist and electric charge emerges with protons and electrons.

Time does not exist.

This epoch is similar to the interiors of black holes, however existing for a very short period: a timeless system composed of first generation particles (electrons and protons) with strong force and electric charge emerging, next to gravity. This phase probably can be described by the Wheeler-Dewitt equation [10], similarly to black hole interiors. The description of this epoch and the events after: emergence of time and entropy are based on a reversed model of the black holes [4].

In the period of cosmic inflation the calculated speed of expansion exceeded the speed of light, creating a contradiction with the theory general relativity. Since there was no time, there was no speed, but we can speak about rate of cosmic inflation without a time parameter. Thus the second discrepancy of the Standard Model is answered too: both the calculations of particle physics on the inflation and Einstein's theory of general relativity are correct, simply time is missing as a parameter.

Between the 'particle phase' and the 'wave-particle' phase time emerges with entropy, this is point $t=0$ of the Universe - the beginning of time. As the wave function starts here, photons are born and light exists in the universe since this point.

3. The third 'wave-particle' phase is characterized by the appearance of time and entropy. *Entropy emerges when the first electron-proton pair forms an atomic nucleus or a neutron (with a gluon).* As entropy starts to grow from zero, time emerges.

Since time emerged, the wave function starts: the emergence of the weak force and electromagnetism [9]. With the emergence of time and the wave function quantum mechanics works properly. The Einstein equations become complete, so general

relativity works due to the emergence of its reference framework the Minkowski-spacetime.

As the weak force and electromagnetism emerge, they complement the existing strong force and gravity, so the four fundamental forces exist as we know them in the Universe. The universe expands since this epoch as described by the Standard Model, based on general relativity. The modified description of the epochs of the universe since the Big Bang is presented on Figure 3.

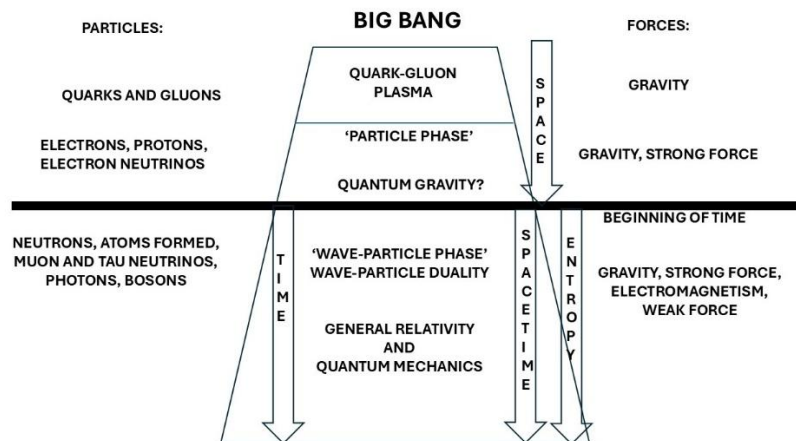


Figure 3: A description of the phases of the Big Bang - from the perspective of space, time, entropy and fundamental forces

Consequences for the Description of the Big Bang and for Early Phases of the Universe

Description of the Big Bang by the Standard Model needs to be modified with the two phases without time. They are described as '*quark-gluon phase*' and '*particle phase*' in this theory.

The '*quark-gluon plasma*' and '*recombination*' are already there in the standard descriptions of the Big Bang. The sequence of events in this theory is the same as in the Standard Model due to causality and gradual emergence of the four fundamental forces. According to the Standard Model the '*quark-gluon plasma*' lasted between 10^{-5} and 10^{-4} seconds, however we need to note that time cannot be interpreted in the '*quark-gluon plasma phase*' of this theory.

The next '*particle phase*' of the theory includes the following periods of the Standard model (the time given in the SM is 1 to 10 seconds, but we cannot interpret time again):

1. *The Hadron Epoch* when quarks and gluons to bind together via the strong force into hadrons (protons and neutrons).
2. *The Lepton Epoch* when most hadrons and antihadrons annihilated leptons (electrons, neutrinos, and positrons) dominated.

The consequent '*wave-particle phase*' starts after this, when the first atomic nuclei were formed and time starts here.

3. This is *Big Bang Nucleosynthesis epoch of the Standard Model* (10 seconds to 20 minutes) when protons and neutrons fused together to form the very first atomic nuclei.

The difference between the two theories is up to 20 minutes according to the time dimension of the Minkowski-spacetime. It is still important to state that time cannot be interpreted without entropy before the *Big Bang Nucleosynthesis epoch of SM* (the ‘*wave-particle phase*’ of this theory).

The Age of the Universe

The consequence of the above is that age of the Universe given by this theory is nearly the same as it is given by the Standard model - *approximately 13,8 billion years*. The clarification regarding the existence of time is still important in this description, as it is linked to the entropy-time relation (details of the entropy-time connection will be given elsewhere).

The Size of the Universe

The logical question arise: does this theory changes our estimation on the size of the Universe? The answer is that this change is minimal too.

By calculating the size of the quark-gluon plasma phase of the universe we got the following:

1. The mass of the universe is estimated to be 1.5×10^{53} kg with normal matter and 3.5×10^{54} kg with dark matter.
2. The density of the quark gluon plasma is estimated between 2.7×10^{17} kg/m³ and 5×10^{18} kg/m³.
3. By assuming a spherically symmetric structure of the quark-gluon plasma, the radius of the quark-gluon phase matter could be maximum between 2×10^{-5} light-year and 5.4×10^{-5} light-year without dark matter and between 5.8×10^{-5} light-year and 1.5×10^{-4} light-year with dark matter (without calculating the mass>>energy transitions).
4. The estimation based on the Standard Model’s 20 minutes period for these epochs would give us 3.8×10^{-5} light year for the radius of the original ‘*quark-gluon core*’ of the universe.
5. Since the radius of the observable universe is estimated to be 46.5 billion light years, the difference in the range of 10^{-4} - 10^{-5} light years is negligible, however theoretically important.

With these corrections, there was no *point-like singularity*, but a *core zone at the beginning of the Universe*. The radius of the original core of the universe is between 2×10^{-5} light-year and 1.5×10^{-4} light-year.

What was Before the Big Bang?

At our current knowledge we can trace back the matter until state of quark-gluon plasma. With our knowledge about emergence of matter and energy in a quantity necessary to constitute our Universe, we have two options for origin of the matter:

1. The quark-gluon plasma is a result of a gravitational collapse at the end phase of a collapse in an oscillating universe. The heaviest Super-Massive Black Hole (TON 618) known in the universe has a mass of $6,6 \times 10^{10}$ solar mass, while the mass of the Universe is 1.5×10^{22} solar masses. With such mass, the result of the collapse cannot be stopped by the strong force and it can result in quark-gluon plasma.

A research [11] estimated that in the case of primordial black holes existed before a Big Bounce, the black holes greater than 90 meters could survive a Big Bang-like event. In case we could find such Primordial Black Holes, these could be the indirect proofs of an oscillating Universe.

2. The other option is the intrusion of matter from another universe via a white hole. His case might be a result of the gravitational collapse of another universe. In this case the existence of parallel universes from the same origin is possible.

CONCLUSIONS

The modified theory explains the incapacity of the Standard Model to describe the first 10^{-43} seconds of the Big Bang: as there was no time and no spacetime, we cannot describe the Big Bang within the framework of general relativity or quantum mechanics. The theory identifies the condition not met for the existence of a Hawking-Penrose singularity: Einstein's equations do not hold due to the lack of the time dimension and as a result of this, the Minkowski-spacetime did not exist.

The provided explanation for the breaking of Minkowski-spacetime explains the limitations of general relativity and quantum mechanics due to the disappearance of the time dimension. The theory is based on a reverse application of the solution of the black hole information paradox and a description of black hole interiors: there time stops and ends at the event horizon of black holes, while at the Big Bang time and entropy and time emerge after an initial phase resembling black holes.

The theory also explains the problem with the inflation period of the Big Bang, where the inflation speed exceeded the speed of light: as time did not exist during the inflation period, we cannot interpret speed in that epoch, instead we can speak about rate of cosmic inflation.

The theory provides a framework for the description of the phases of the Big Bang and provides an indication on how the four fundamental forces emerged, starting with gravity, followed by the strong force and later complemented by the weak force and electromagnetism.

It is also possible to estimate the size of the original core of the universe composed of quark-gluon plasma, in the range of 10^{-4} - 10^{-5} light years. The age and estimated size of the Universe are in the same range as the ones given by the Standard Model, however important clarifications were provided the existence of time in the first phases of the Big Bang.

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