The Inflation in the Scale-Symmetric Theory

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Abstract: Nature is the inseparable mixing of the classical structures (the bare particles) and the quantum fields in which the quantum effects are turbulent i.e. there are rapid random changes in local densities of quantum field. The quantum time is going turbulently so the precise quantum methods should by free from such time. The internal structures of the classical bare particles/objects determine the possible interactions of them with quantum fields so we cannot neglect these structures. Such structures are neglected in the mainstream theories (there appear the sizeless points or flexible loops). In the string/M theory, a classical structure is defined but there is the fundamental wrong assumption that we can reduce all classical structures to the same closed string. Moreover, the fundamental closed strings have smaller size than it is assumed in the string/M theory and they are inflexible. To fit theoretical results to experimental data there appear approximations, mathematical tricks and free parameters. Such incoherent methods cannot lead to the lacking part of ultimate theory. Instead applying the incoherent methods we should seek interactions that lead directly to statistically stationary distributions of energy and/or matter i.e. we should directly look for eigenstates. To describe the inflation we should seek the metastable states (the regions of the expanding Cosmos with relatively slower changes in density) and stable states. Such methods are presented in this paper. The VEV and Planck values are calculated as well and we described the phenomena that stopped the inflation.

1. Introduction

The General Relativity leads to the non-gravitating Higgs field composed of tachyons [1A]. On the other hand, the Scale-Symmetric Theory (SST) shows that the succeeding phase transitions of such Higgs field lead to the different scales of sizes [1A]. Due to the saturation of interactions via the Higgs field and due to the law of conservation of the half-integral spin that is obligatory for all scales, there consequently appear the superluminal binary systems of closed strings (entanglons) responsible for the quantum entanglement, stable neutrinos and luminal neutrino-antineutrino pairs which are the components of the luminal Einstein spacetime (it is the Planck scale), cores of baryons, and the cosmic structures (protoworlds) that evolution leads to the dark matter, dark energy and expanding universes [1A], [1B]. The non-gravitating tachyons have infinitesimal spin so all listed structures have internal helicity (helicities) which distinguishes particles from their antiparticles [1A]. SST shows that a fundamental theory should start from infinite nothingness and pieces of space [1A]. Sizes of pieces of space depend on their velocities [1A]. The inflation field started as the liquid-like field composed of non-gravitating pieces-of-space/tachyons [1A]. Cosmoses composed of universes are created because of collisions of big pieces of space [1A], [1B]. During the inflation, the liquid-like inflation field (the non-gravitating superluminal Higgs field) transformed partially into the luminal Einstein spacetime [1A]. In our Cosmos, the two-component spacetime is surrounded by timeless wall – it causes that the fundamental constants are invariant [1A], [1B].

Due to the symmetrical decays of bosons on the equator of the core of baryons, there appears the atom-like structure of baryons described by the Titius-Bode orbits for the nuclear strong interactions [1A].

In the quantum fields there are the random creations and annihilations of the pairs of quantum particles, of 4-particle systems, and so on. This causes rapid variation of local densities in the two-component spacetime and the quantum fields. We can define local unit of time as the mean time between collisions of the components of a spacetime or a quantum fields. This means that in quantum fields there are random changes of local unit of time. We can define unit of time taking into account different phenomena, for example, as the period of spinning of a vortex that represents a quantum particle. But a vortex can consists of smaller and smaller vortices so there are many different units of time associated with a quantum particle. Moreover, in a defined place can appear different vortices i.e. different units of time. This means that in quantum fields time is going turbulently. We cannot solve univocally equations containing turbulently going time. It causes that to fit the theoretical results to experimental data there appear approximations, mathematical tricks and free parameters. We can see that in quantum physics the equations dependent on time are useless. We must apply new methods that should be independent from time.

We should seek statistical stationary distributions of energy and/or matter i.e. we should directly look for eigenstates. We should seek interactions that lead directly to the eigenstates.

To describe the inflation we should describe the succeeding metastable states (the regions of the expanding Cosmos with relatively slower changes in density) and stable states.

The classical bare particles and the two components of spacetime appeared due to the inflation. The interactions of the classical structures of the bare particles with the classical ground state of the two-component spacetime leads to the quantum fields inseparable associated with the classical bare particles. Nature is composed of the classical ground states of the spacetime and classical bare particles and of the quantum fields associated with the bare particles. Nature is the systems composed of the inseparable classical stable structures and quantum structures (the fields composed of the created pairs and the remnants of annihilating virtual or/and real pairs of particles). The interactions of the classical structures with the quantum fields lead to the anomalous parts of the physical quantities as, for example, to the anomalous magnetic moment of electron. We can define univocally only the classical time associated with motions of the classical structures in classical ground state of spacetime - it is the relative time in the General Relativity.

We cannot univocally define quantum time i.e. time should not appear in problems in which dominate the quantum effects. Since quantum time can be defined arbitrarily so equations of motions in quantum physics lead to solutions that cannot be realized by Nature also. For example, at the end of June 1982 and the beginning of July there was in University of Cambridge an international workshop concerning the inflation and the very early Universe (the Nuffield conference/meeting). Among the other things there was discussed the anisotropy with small fluctuations. Many great theorists obtained very different results concerning the same problem in spite of applying the same equations. The results were from 10^{-4} to 10^{2} i.e. the upper limit was one million times higher than the lower one. The conclusion was that the authors applied different definitions of time so they obtained different results. You know, they claimed that non-dimensional result (the small fluctuations of temperature in relation to the mean temperature) depends on a definition. This leads to conclusion that the same differential equations can give different solutions. It shows that Feigenbaum is right, i.e. to understand the quantum behaviour of Nature the differential equations dependent on time are useless. Quantum processes are turbulent so time is going turbulently as well. There is not some evolution of a wave function dependent on defined univocal time – there is the drift to reach a state of equilibrium defined by the leaking structure of the classical bare particles. Just there is a scaling that follows from the phase transitions of the superluminal non-gravitating Higgs field. Of course, the differential equations of motion are fruitful to describe the classical phenomena.

Each set of phenomena is realized by Nature if leads to the classical objects arising due to the phase transitions of the fundamental spacetime described within the Scale-Symmetric theory, especially it concerns the internal structure of the Einstein-spacetime components (the neutrino-antineutrino pairs) and the core of proton. Just due to the Feigenbaum constant $\delta = 4.6692016...$, different systems behave the same. There are some structures in non-linear systems such as $x_{i+1} = r\, x_i\, (1 - x_i)$ (a parabola that a half can approximately represent the inverse square law) and $x_{i+1} = r \sin(\pi\, x_i)$ (a sinus function that can represent the imaginary part of the exponential function with the base equal to the base of the natural logarithm) that in a limit behave the same i.e. in a limit the ratio of the re-duplicators of the periods reaches the Feigenbaum constant. A part of the first function can represents, for example, the classical law of universal gravitation or lines of forces produced by a charge whereas the second a distribution of virtual pairs i.e. a quantum field.

New methods must be based on the phase transitions of the Higgs field and interactions of the bare particles with the quantum pairs or pairs of pairs, and so on, via the classical two-component spacetime and quantum fields. Such physics is mathematically very simple. It follows from the fact that the interactions are defined by the internal structure of the bare particles (such structure is neglected in the mainstream theories so there appears the renormalization that is mathematically incoherent – just the applied formula $\infty - \infty = constant \neq 0$ is incorrect; energy of any field cannot be infinite; infinite energy follows from incompleteness of applied theories). The new methods cause that free parameters are not needed and number of initial parameters is reduced to seven. Due to the fact that in the new methods a definition of time is not needed, they directly lead to the eigenstates. The scaling is directly associated with the different values of the couplings of the bare particles with the classical and quantum fields.

The mainstream quantum physics and general relativity define the limitations for experiments, not for Nature. It is true that we cannot send a photon with speed higher than the speed of light in vacuum and it is true that we cannot simultaneously measure energy of a system and its lifetime. On the other hand, it is not true that Nature cannot communicate with superluminal speeds i.e. Nature almost immediately knows the real states of all its parts. It follows from the fact that there are the superluminal non-gravitating particles which trajectory cannot be measured in experiments. SST shows that in our Cosmos, the maximum delay for gravity is approximately $2 \cdot 10^{-67}$ s (it follows from the size of our Cosmos [2] and speed of tachyons [1A]) whereas for the quantum effects is $6 \cdot 10^{-38}$ s (it follows from the size of our cosmos and linear speed of the entanglons responsible for the quantum entanglement [1A]).

The "turbulent" quantum time causes that the Feynman's discovery of a formal connection between the classical Lagrangian and canonical quantum mechanics [3] is not realized by Nature but it shows that classical fields can lead to quantum effects. The standard path integral cannot change it as well. A wave function can describe the possible configurations of the virtual structures but we cannot to arrange them in time because we cannot define a real time. Physicists propose to break the equivalence of the Feynman's path integral and the canonical quantum mechanics, for example, by adding to the Schrödinger equation non-linear terms. But we can see that we never will able to unify the classical relativistic well-defined time with the "turbulent" quantum time. There are not exact solutions of the equations dependent on time for the quantum phenomena. Then, to obtain solutions consistent with experimental data we must apply approximations, mathematical tricks and free parameters. Such "methods" do not lead to the lacking part of Theory of Everything.

In this paper we described the metastable states and the final stable state that appeared during the inflation. The VEV and Planck values are calculated as well and we described the phenomena that stopped the inflation.

2. The metastable states during the inflation and the stable state at the end of the inflation

2.1. The initial conditions [1A]

Due to a collision of two very big pieces of space, there appeared a liquid-like spacetime composed of tachyons. This spacetime was perfectly ordered so its entropy was smallest.

Mean radius of tachyon is

$r_t = 0.47571055 \cdot 10^{-64}$ m.

Mean linear speed of tachyon is

$v_t = 2.386343972 \cdot 10^{97}$ m/s.

Mean speed on equator of mean tachyon is

$v_{st} = 1.725741 \cdot 10^{70}$ m/s.

Mean inertial mass of tachyon is

$m_t = 3.752673 \cdot 10^{-107}$ kg.

Dynamic viscosity resulting from smoothness of surfaces of tachyons is

$\eta = 1.87516465 \cdot 10^{138}$ kg m^{-1} s^{-1}.

Mean inertial mass density of the Higgs field is

$\rho_N = 2.645834 \cdot 10^{-15}$ kg m^{-3}.

Today this spacetime is classical since today from the tachyons cannot be created any particles or pairs of particles, and so on.

Mean mass density of the Einstein spacetime is

$\rho_E = 1.10220055 \cdot 10^{28}$ kg m^{-3}.

Today the ground state of this spacetime is classical whereas the excited states behave as the quantum particles and such particles are the components of the quantum fields in which time is going turbulently.

Applying the above initial parameters, we can calculate inertial mass density of a tachyon which is the density of timeless space [1A]

$\rho_t = 8.32192436 \cdot 10^{85}$ kg m^{-3}.

We can as well calculate the Reynolds number for maximum dense Higgs field (it is the initial state of the inflation field composed of tachyons) [1A]

$N_R = 1.0076047 \cdot 10^{-19}$,

and the radius of closed string which can be produced due to the value of the Reynolds number

$r_1 = (2r_t) / N_R = 0.94424045 \cdot 10^{-45}$ m.

The initial 7 parameters lead to new set of 7 parameters [1A]:
Gravitational constant: $G = 6.6740007 \cdot 10^{-11}$ m^3/(kg s^2)
Half-integral spin: $\hbar/2 = 1.054571548 \cdot 10^{-34}/2$ Js
Speed of light in spacetimes: $c = 2.99792458 \cdot 10^8$ m/s
Electric charge of electron: $e = 1.60217642 \cdot 10^{-19}$ C
Mass of electron: $m_{electron} = 0.510998906$ MeV
Mass of neutral pion: $m_{pion(o)} = 134.97674$ MeV
Mass of charged pion: $m_{pion(+-)} = 139.57041$ MeV.

Due to the phase transitions of the Higgs field composed of tachyons there appeared during the inflation the binary systems of the closed strings (the superluminal entanglons) and the Einstein spacetime composed of the neutrino-antineutrino pairs. Today, due to the phase transitions, there can appear the next classical structures i.e. the cores of baryons that lead to the atom-like structure of baryons [1A] and the cosmic structures/protoworlds that lead to the new cosmology [1A], [2]. The three last classical structures consist of torus and condensate in its centre. The tachyons have infinitesimal spin in relation to the reduced Planck constant so the closed strings have internal helicity. Due to the phase transitions, the helicity and spin of the closed strings is adopted by the greater and greater tori – the closed strings and tori are the simplest objects that can have internal helicity. Since the linear speeds of components of a torus must be conserved and because the tori are the stable structures so there appear the convergent radial velocities that cause that there appears condensate in centre of torus.

Due to the saturation of interactions of the entanglons via the Higgs field, we can define the fundamental formulae for the phase transitions of this spacetime. Knowing the number of tachyons the closed strings consist of, K^2 ($K^2 = 2\pi r_1 / (2r_t)$) we can find number of tachyons in the greater and greater tori K^4, K^8, K^{16} (greater tori are not in existence since their sizes are greater of our Cosmos [2]. This remarks lead to two initial formulae.

The mean radii of the tori of stable objects are

$$r_d = r_1 K^{d-1}, \tag{1}$$

where $d = 1, 2, 4, 8$.

The rest masses of the tori of the stable objects are

$$m_d = m_1 K^{2(d-1)}, \tag{2}$$

where m_1 is for the closed string.

On the torus of the core of baryons appear some bosons. Their symmetrical decays lead to the Titius-Bode law for the strong interactions i.e. lead to the atom-like structure of baryons

$$R = A + dB, \tag{3}$$

where $A \approx 0.7$ fm, $B \approx 0.5$ fm and $d = 0, 1, 2, 4$.

The 7 initial parameters and 3 very simple fundamental formulae are the foundations of Nature.

2.2 The first metastable state

Due to the dynamic viscosity of the tachyons, there appeared the condensates of the tachyons in which were produced the binary systems of closed strings (entanglons). Why binary systems, not free closed strings? It is because global and local total internal helicity must be equal to zero. From the initial conditions follows that spin of each closed string is half-integral whereas of the entanglons is unitary. The non-gravitating tachyons behave as pseudoscalars (in physics, a pseudoscalar changes sign under a parity inversion such as improper rotation – it is possible since the tachyons have infinitesimal non-gravitating spin). This means that the field composed of the condensates of the tachyons is the pseudoscalar field. From the tachyons in the condensates there were produced the entanglons which due to their spin are the vector particles with defined eigenvector. But the entanglons as well are the non-gravitating particles – due to the opposite internal helicities of the closed strings in an entanglon and due to their interactions with the free tachyons, they produce the antiparallel half-jets only. We can see that the entanglons are the eigenvectors of the non-gravitating scalar condensates/fields. We can see as well that the mass matrix of the pseudoscalar and scalar fields is equal to zero. Since the pseudoscalar and scalar fields are non-gravitating so the spins are imaginary i.e. such fields behave as spinless fields. The non-gravitating scalar condensates are the massless Goldstone bosons [5], [6] in which are defined the directions of the Goldstone fields by the antiparallel half-jets produced by the entanglons.

Applying the initial conditions we can calculate the VEV (the vacuum expectation value) for the non-gravitating Goldstone bosons/condensates – they consist of the tachyons and entanglons. Due to the dynamic viscosity, there appears the centrifugal force acting on a tachyon on surface of the Goldstone boson that depends on curvature of the surface of a condensate

$$F_t = m_t v_t^2 / R_{cond} , \qquad (4)$$

where R_{cond} denotes the radius of the condensate.

On the other hand, we can define friction force acting on spinning tachyon as product of dynamic viscosity, Reynolds number, arm of the friction force, and the spin speed of the tachyon in the point of application of the friction force

$$F_t = \eta N_R r_t v_{st} . \qquad (5)$$

Comparing formulae (4) and (5) we obtain

$$R_{cond} = m_t v_t^2 / (\eta N_R r_t v_{st}) = 1.3777 \cdot 10^{-37} \text{ m}. \qquad (6)$$

The radius R_{cond} is very close to the radius of condensate composed of entanglons in centre of neutrinos [1A].

Now we can calculate the VEV i.e. the inertial mass of the condensate

$$VEV = M_{cond,inertial} = 4 \pi \rho_t R_{cond}^3 / 3 = 9.1157 \cdot 10^{-25} \text{ kg} = 511.4 \text{ GeV}. \qquad (7)$$

It is close to the VEV applied in the mainstream electroweak theory multiplied by 2 (≈ 493 GeV). On the other hand, in SST appears the 4-particle symmetry, [1A], so mass of the 4 composite Higgs bosons each with a mass of 125 GeV is 500 GeV and it is close to the VEV. It is the reason that the Higgs mechanism acts correctly within the mainstream electroweak theory. Mass of the *Z* boson is greater than the *W* boson so their structures are different. This leads to conclusion that to conserve the symmetries of the *VEV* defining a spinless condensate there must appear two *Z* bosons with antiparallel spins. There as well should be the same number of each type of charge. This means that *VEV* decays as follows

$$VEV \rightarrow 2\,(W^{+} + W^{-}) + 2\,Z \approx 504 \text{ GeV}. \quad (8)$$

What should be the unimportant correction in the GSW electroweak theory that leads to the two times higher *VEV* but which does not change the final results i.e. the masses of the *W* and *Z* bosons? We know that we use the fifth gamma matrix γ^5 to project a Dirac field onto its left-handed and right-handed components. There appear following expressions $(1 \pm \gamma^5)/2$. In the GSW theory we compare two expressions describing the same effective interaction so in both expressions there should be the same expressions containing the fifth matrix. But we can see that they are not [7]. Due to the four-boson symmetry characteristic for the weak interactions, [1A], there, due to the pairs of pairs of the fermions [1A], instead the $(1 + \gamma^5)/2$ should be $(1 + \gamma^5)$. Such correction leads to *VEV* two times higher. But such correction does not change the final results i.e. the masses of the *Z* and *W* bosons. It is because the masses are directly proportional to *VEV* and there instead the bosons appear their pairs to conserve the symmetries of the condensate which energy defines the *VEV*. Emphasize that the fifth gamma matrix is useful in discussion of quantum chirality.

2.3 The second metastable state

The exchanges of the vortices produced in the Higgs field near the entanglons (it is due to the spin speeds and internal helicities of the components of an entanglon) cause that there appear surfaces composed of the entanglons. The unitary spins of the entanglons are perpendicular to the surfaces. Such surfaces we will refer to as the hyper-surfaces.

2.4 The first stable state

The greater structures should adopt the main properties of the binary systems of closed strings i.e. shape, internal helicities and spins. This means that there appear tori that surfaces are the hyper-surfaces. They are the components of neutrinos which can differ due to the senses of the spins of entanglons and can differ because of the internal helicity/chirality. It leads to four different neutrinos. Since spin of created objects must be unitary (as the entanglons) so there appear the neutrino-antineutrino pairs i.e. the components of the ground state of the Einstein spacetime. The Einstein-spacetime components are the zero-helicity/chirality vector particles. But we can see that the zero-helicity follows from the opposite internal helicities of the components of an Einstein-spacetime component. At distances sufficiently larger than the size of neutrinos, the jets produced by entanglons (a neutrino consists of) are divergent and produce gradient in the Higgs field – it is the gravitational field so neutrinos are the smallest objects carrying the gravitational mass. They are the lightest Principle-of-Equivalence particles. Their properties are described here [1A].

We can see that the Einstein spacetime is a vector field.

The three states described in points **2.2**, **2.3** and **2.4**, are the succeeding stages in the Higgs mechanism that leads from the non-gravitating tachyons to the lightest Principle-of-Equivalence Einstein-spacetime components. More details concerning the Higgs mechanism we can find in following paper [4]. We can see that particles acquire their gravitational mass due to rotation of the spins of the entanglons (i.e. due to rotation of the directions of the Goldstone fields) in such a way that new field (i.e. the spin of an Einstein-spacetime component) is perpendicular/orthogonal to the spins of entanglons placed on equators of an Einstein-spacetime component. Such transformation of the scalar and pseudoscalar fields in Lagrangian causes that there appears mass matrix. A part of mathematical mainstream description of the Higgs mechanism we can find, for example, here [7].

There are the two components of spacetime: the spacetime composed of free tachyons that did not transform into the Einstein spacetime (the Higgs field) and the Einstein spacetime. The first spacetime is associated with gravity whereas the second with electromagnetism and the strong and weak interactions. Can we calculate the ratio of the densities of the two components of spacetime from the initial conditions? The calculated mass of the condensate inside neutrinos is in approximation $1.9 \cdot 10^{-67}$ kg [1A] and is about $4.7 \cdot 10^{42}$ times smaller than the mass of the Goldstone bosons (VEV). On the other hand, the ratio of the constant of electromagnetic interactions of electrons to the gravitational constant is in approximation $4.2 \cdot 10^{42}$ [1A] and it is equal to the present-day ratio of the densities of the Einstein spacetime and the Higgs field.

3. Planck critical quantities

Probability of finding the exchanged entanglons between the Einstein-spacetime components, which are responsible for quantum entanglement, is highest on the equators of the tori [1A] in an Einstein-spacetime component. Distance between centres of the tori in a neutrino-antineutrino pair is about $2\pi r_{neutrino}/3$ [1A]. This means that distance between the centre of the Einstein-spacetime component and a point on equator is:
$\lambda = r = r_{neutrino}\, sqrt(1 + \pi/3) = 1.6003 \cdot 10^{-35}$ m – this value is very close to the Planck length.

Maximum speed of rotation of an Einstein-spacetime component is the speed of light c. Calculate energy, not mass, associated with length of wave equal to the circumference of a circle that radius is equal to the Planck length (the Planck energy is associated with rotation of the Einstein-spacetime components – they are the non-relativistic particles i.e. their mass does not depend on their motions [1A]): $E = h/(2\pi\lambda c) = \hbar/(\lambda c) = 2.1981 \cdot 10^{-8}$ kg – this value is very close to the Planck mass.

The obtained values lead to the critical time and critical energy density very close to the Planck time and Planck energy.

4. What stopped the inflation?

SST shows that the inflation field expanded inside much bigger piece of space composed of bigger tachyons. In the bigger piece there were only the ordered parallel linear motions so it is the timeless boundary of our Cosmos. It stopped the inflation [1A]. When there appeared the Einstein spacetime then there was an abstract sphere on which the gravitational pressure forced on an Einstein-spacetime component by the matter inside the sphere was equal to the dynamic pressure of this spacetime. It is easy to notice that contrary to the outside of the sphere, inside the sphere the gravitational pressure is lower than the absolute value of the dynamic pressure. This means that outside the sphere, the Einstein spacetime had collapsed to a stable boundary of the Einstein spacetime [1B]. We can see that there should two boundaries of our Cosmos.

5. Summary

Nature is the inseparable mixing of the classical structures (the bare particles) and the quantum fields in which the quantum effects are turbulent i.e. there are rapid random changes in local densities of quantum fields. This means that quantum time is going turbulently so the precise quantum methods should be free from turbulent time.

The internal structures of the classical bare particles/objects determine the possible interactions of them with quantum fields so we cannot neglect these structures as it is in the mainstream theories. In the string/M theory a classical structure is defined but there is the fundamental wrong assumption that we can reduce all classical structures to the same closed string. Moreover, the fundamental closed strings must be inflexible because only then the spin and gravitational constant are invariant.

The neglected structure of the bare particles causes that mainstream theories are very messy i.e. to fit theoretical results to experimental data we must apply approximations, mathematical tricks and free parameters. We can see that such incoherent methods cannot lead to the lacking part of Theory of Everything. Instead applying the incoherent methods we should seek statistical stationary distributions of energy and/or matter i.e. we should directly look for eigenstates. We should seek interactions that lead directly to the eigenstates.

Due to the phase transitions of the Higgs field during the inflation, there appeared the superluminal entanglons responsible for the quantum entanglement and there appeared the Einstein spacetime composed of the neutrino-antineutrino pairs. Today, due to the next phase transitions, there can appear the cores of baryons that lead to the atom-like structure of baryons, and the cosmic structures/protoworlds that lead to new cosmology. The three last classical structures consist of torus and condensate in its centre. The tachyons have infinitesimal spin in relation to the reduced Planck constant so the closed strings have internal helicity. Due to the phase transitions, the helicity and spin of the closed strings is adopted by the greater and greater tori – the closed strings and tori are the simplest objects that can have internal helicity. Since the linear speeds of components of a torus must be conserved and because the tori are the stable structures so there appear the convergent radial velocities that cause that there appears a condensate in centre of torus.

To describe the inflation we must describe the succeeding metastable states (the regions of the expanding Cosmos with relatively slower changes in density) and stable states and such methods are presented in this paper and other papers concerning particle physics, cosmology and mental processes.

Here as well we calculated the VEV and Planck values from initial conditions defining the initial inflation field.

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