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Abstract- Origins of dark energy and inflation in semiclosed Friedman model universe are sought by examining the imaginary pair of gravitationary bound Planckeon-Higgs boson composite requiring temperature $T \sim 10^{15}$K for thermal creation. Inflation is likely to be related to the singular nature of the transition amplitude $D(s^2)$ of the Higgs boson obeying PC-and T-symmetric Klein-Gordon equation, between neighboring points separated by a space like distance $s^2 = (ct)^2 - r^2 < 0$ in the ultraviolet region outside the light cone, past and future, violating time-symmetry and local causality.

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I. Introduction

Previous discussions[1,2] on the Plankeon origin of dark energy are extended to include the imaginary pair of gravitationally bound Planckeon-Higgs boson composite. The inflationary superluminal expansion of the universe is likely to be related to a singular nature of the transition amplitude of Higgs boson between two neighboring points separated by a spacelike interval in the ultraviolet region outside the light cone, future and past, favoring the creation of the boson composites.

II. Standard Inflation

In the standard inflation theory, the universe starts either from a large quantum fluctuation of a pre-existing spacetime metric at Planck radius $l_{pl} \sim 10^{-33}$cm and time $l_{pl}/c \sim 10^{-43}$cm, or from the singular hot Big Bang at temperature $T_B = 10^{27}$K occurring at $r = r_B \sim 10^{-25}$cm and time $\sim 10^{-35}$sec, expanding the radius of the universe from r_B to

$$(T_0/T_B)R = (3/10^{27})(10^{28}\text{cm}) \sim 10\text{cm}, \qquad (1)$$

where T_0 is the present temperature and R the present radius of the universe, explaining the large scale homogeneity of the universe.

III. Friedman Inflation

Consider a Friedman universe, filled with a uniform distribution of constant energy density ρ_Λ, having Euclidean radius R, mass $M = \rho_\Lambda V$ and volume $V = 4\pi R^3/3$. The motion of a test particle ticking (quantized) with Planck period $l_{pl} = \hbar/m_{pl}c$ and moving on the surface r of the universe is described by the PC- and T-symmetric line element ds^2 with Lorentz-Friedman-Reissner-Nordström metric:

$$\begin{aligned} ds^2 &= c^2 g_{tt} dt^2 - g_{rr} dr^2 \ (g_{tt} = g_{rr}^{-1}), \\ &= c^2[1 - r^2/r_g^2 + L^2/(m_{pl}cr)^2] \\ &= c^2(1 - r^2/r_g^2 + L^2 l_{pl}^2/r^2), \\ &= c^2[(1 - r/r_g)(1 + r/r_g) + L^2 l_{pl}^2/r^2)], \qquad (2) \end{aligned}$$

where $r_g = 2GM/c \leq R$ is the gravitational radius of the closed (= R) and semiclosed (< R) universe, and

$$\begin{aligned} L &= m_{pl} r^2 d\theta/dt, \\ &= l_\theta \hbar/2\pi, \ l_\theta = \text{integer}. \qquad (3) \end{aligned}$$

is the quantized angular momentum of the test particle crossing the time axis of the future light cone at $ct = l_{pl}$ in Minkowski space.

There the test particle moves on the 4-dimensional hyperboloid, $(ct)^2 - r^2 = l_{pl}^2$ (Lorentz sphere), with velocity dr/dt obtained by solving $ds^2 = 0$. We find that the light velocity changes from superlumial to luminal and then to subluminal as

$$\begin{aligned} dr/dt &= c\,(g_{tt}/g_{rr})^{1/2} \\ &= c(1 - r^2/r_g^2 + L^2 l_{pl}^2/r^2). \\ &= c\,(1 - l_{pl}^2/r_g^2 + L^2) > c \text{ at } r = l_{pl} \\ &= c \ \text{ at } r = r_c = (r_g l_{pl})^{1/2} \\ &= 0 \ \text{ at } r_c < r < r_g - r_{pl} \\ &> c \ \text{ at } r = r_g. \qquad (4) \end{aligned}$$

The inflationary history of the universe can thus be described as a superluminal expansion of the universe starting at $r = l_{pl}$ and ending at $r_c = r = (r_g l_{pl})^{1/2}$. The astronomical observations[4] of the large-scale homogeneity of the distribution of matter and galaxy formation on the scale of 10^{10} light years can be explained by the superluminal and bi-directional EPR causal connection[1,2] between radius $r = l_{pl}$ and r_c, while stars, clusters of galaxies, voids and other structures larger than $l0^8$ light years, violating a perfect homogeneity by less than a part in a thousand 10^3, seem to indicate the

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quantized angular momnetum less than $l_\theta \sim 10^3$ so that $r_c = (r_g l_{pl})^{1/2} = l_\theta 10^{-2}$cm = 10cm.

IV. De-Sitter Inflation

The de-Sitter universe filled with Planckeon energy $m_{pl}c^2 = \hbar c/l_{pl}$ is described by the line element:

$$ds^2 = c^2(1 - \Lambda r^2) = c^2(1 - r^2/l_{pl}^2), \quad (5)$$

where Λ is the cosmological constnt. The light velocity is determined from $ds^2 = 0$ as

$$dr/dt = c(1 - r^2/l_{pl}^2). \quad (6)$$

Thus Einstein's equation with cosmological term Λ predicts a subluminal inflation:

$$\exp(\surd\Lambda ct) = \exp(ct/l_{pl}) = \exp 10^{43} t, \quad (7)$$

starting at t = 0 with dr/dt < c and ending at Planck time $t_{pl} = l_{pl}/c$ with dr/dt = 0 and $\exp(\surd\Lambda ct) = 0$, showing an uncertainty relation between position l_{pl} and momentum $m_{pl}c$: $l_{pl}m_{pl}c = \hbar$ defining the Compton wavelength $l_p = \hbar/m_{pl}c$ of a Planckeon.

V. Mass Defect of Friedman Universe

Consider the Panckeon model Friedman universe filled with uniform distribution of constant dark energy density ρ_Λ. During the subluminal expansion of the universe from radius t = r_c to $R - l_{pl}$, the mass defect develops between Newtonian mass $M = \rho_\Lambda V$ and the general relativistic proper mass M_p calculated from the proper radius $R_p = \int^R g_{rr} dr$ and the proper volume $V_p = 4\pi R_p^3/3$:

$$M_p = \rho_\Lambda V_p = (3/2)(R/r_g)^3 \sin^{-1}(R/r_g) M. \quad (8)$$

We find that M_p increases with the increase of the world radius from $r \sim l_{pl}$, where $l_{pl}/r_g \sim 1$. With further increase of r towards $r = r_g - l_{pl}$, R_p decreases towards l_{pl}, where $r/r_g \sim 1$, forming a gravitational semiclosure with surface area $4\pi l_{pl}^2$ having holographic information content $4\pi(R/l_{pl})^2 = 10^{120}$.

VI. Magnetic Monopole and Nambu's Mass Formula

Recently in June 2016 in Tokyo a successful artificial creation of magnetic monopole, using spin ice of rare earth metals at low temperature below critical, was anounced.[5] The magnetic monopole was predicted by Dirac in 1931 and its neccessary existence was emphasized by Zel'dovich, t'Hooft and others in the grand unified theory as a primordial problem. We here point out that the monopole mass spectrum

$$m_{mono} = n(\hbar c/e), \quad n = \text{integer} \quad (9)$$

is hidden in Nambu's mass spectrum[1] for elementary particles discovered in 1952 before grand unification of gauge fields:

$$m_n = n(\hbar c/e^2)m_e, \quad n = \text{integer},$$
$$= nGm_{pl}^2/L = (137n/2)\, m_e, \; m_e = \text{electron mass},$$
$$n = 3, 4, 14, 15, 16, 17, 18, 19, 24, 33 \quad (10)$$

for μ, π, K, τ (mesons), P/N (proton/neutron), Λ, Ξ, Ω, Λ_c (baryons).

The angular term in the line element ds^2 of Friedman universe (Eq.(2)) can give magnetic monopoles of mass $m_{mono} = 10^{-3}m_{pl}$ with mass spectrum

$$m_{mono} = l_\theta 10^{-3} m_{pl}, \; l_\theta \text{ integer}, \quad (11)$$

indicating energy emission during quantum transitionon from higher, say, $l_\theta \sim 10^2$ to lower orbit (circular) on the perturbed background radiation at temperture $T = 10^{32}$K. We note that the higher orbit is highly multi-directional, locally violating the spherical symmetry of the Friedman universe.

It is conceivable that the gravitationally bound pair of Planckeon and magnetic monople creates the binding energy, solving the primordial problem:

$$Gm_{mono}m_{pl}/l_{pl} = 10^{-3}m_{pl}c^2 = 10^{19}\kappa T. \quad (12)$$

VII. Cosmologial Implication of Mass Spectrum

In his Nishina Memorial Lecture in 1983 t'Hooft[6] asked: Is quantum field theory a theory? and showed an artistic view of mass spectrum of relatively stable point-like paricles. There Nambu's mass spectrum ranging from 1Mev towards 100Gev (leptons, mesons and hadrons) is extended to include gauge paricles, real and imaginary, required to make a quantum field theory a theory. G. t' Hooft calls the mass range between 10^{16} to 10^{19}Gev a trangent range, and the range beyond 10^{19}Gev the blackhole range characterized by the spectrum density $\rho(E) = \exp(4\pi M/m_{pl})^2$ of the blackhole of 10^{19}Gev scale mass M.

We here propose to call the 10^{20}Gev scale mass M the Newtonian mass of semiclosed Friedman universe (r_g < R) having Planck scale proper mass $M_P \sim m_{pl}$ with holographic information content $4\pi(M/m_{pl})^2 = 120$.

VIII. Plankeon-Higgs Boson Origin of Dark Energy

In 2014 the CERN high energy proton-proton collision experiment detected the Higgs boson with mass m_H of about 133 proton mass m_P:

$$m_H \sim 10^2 m_P \sim 10^{-17} m_{pl} \sim 10^{-22}\text{g}. \quad (13)$$

Being a scalar field, the Higgs boson has no spin, has no electric and color charge. It has its own anti-particle and CP-symmetry.

The cosmological implication of the graviton-Higgs boson composite has been discussed[7] in curved space time as it may generate huge cosmological constant Λ in negative sense, while its anti-boson composite may flatten the curve in positive sense. We here consider a gravitationary bound Plankeon-Higgs boson composite having potential energy:

$$Gm_H m_{pl}^2/l_{pl} = 10^{-17} m_{pl} c^2 \sim 10^{15} \kappa T, \qquad (14)$$

in positive sense as a source of dark energy filling the evolutionarily earlier upper hemisphere of the semiclosed Friedman universe. Towards a solution of the primordial problem of observed abense of magnetic monopoles, we may also consider the monopole-Higgs boson composite having potential energy in positive sense:

$$Gm_H m_{mono}^2/l_{pl} = 10^{-14} m_{pl} c^2 \sim 10^{12} \kappa T. \qquad (15)$$

IX. Singular Nature of Higgs Boson

Consider a scalar field $\varphi(r, t)$ created by a Higgs boson at $(r, t) = (0, 0)$ obeying CP and T symmetric Klein-Gordon equation: [12,14]

$$[\partial^2/\partial^2(ct) - \partial^2/\partial^2 r - (m_H c/\hbar)^2]\varphi$$

$$[(\partial/\partial(ct) - \partial/\partial r)(\partial/\partial(ct) + \partial/\partial r) - (m_H c/\hbar)^2]\varphi$$

$$= \delta(r, t), \qquad (16)$$

giving the amplitude of transition (propagator) $D(s^2)$ between two points separated by 4-dimensional distance $s^2 = (ct)^2 - r^2$: [12,14]

$$D(s^2) = -\delta(s^2)/4\pi + (\lambda/4\pi s)H_1^{(2)}(s/\lambda)$$

$$\sim \delta(s^2) \text{ on the light cone } ds^2 = 0 \qquad (17)$$

$$\sim (1/|s|)^{3/2}\exp(-is/\lambda) \text{ within the light cone } ds^2 > 0, \qquad (18)$$

$$\sim (1/|s|)^{3/2}\exp(-|s|/\lambda) \text{ outside the light cone } ds^2 < 0. \qquad (19)$$

Here $H_1^{(2)}$ is the Hankel function of the sccond kind and $\lambda = \hbar/m_H c$ is the Higgs wavelength. We find that $D(s^2)$ gives a singular attractive potential:

$$D(s^2) \sim (1/|s|)^{3/2}\exp(-|s|/\lambda)$$

$$\sim (1/|s|)^{3/2} \sim (1/l_{pl})^{3/2}, \qquad (20)$$

favoring the superluminal (spacelike) creation of Planckeon-Higgs boson composites outside the light cone in the transional region between quantum field theory and the blackhole cosmology.

X. Historical Comments

In the early attempts to find origins of quasistellar radio sourses, Zel'dovich,[9] Novikov,[10] Stanyukovich,[11] and others examined models of radiating Planck scale black hole (Planckeon) filled with a scalar field obeying Klein-Gordon equation with spherically symmetric metric.[11] For the radiation to be observed, the inner universe is requred to be open to an asympotically flat Euclidean space though a Schwarzschild bottleneck pulsating with Planck period. As the presently radiating black hole can be a final state of the contracting past universe as well as the initial state of an exanding future universe, we are led to an infinite series of (CP and T symmetric) world within world model under the Middle Way doctorine[2] restated as the unitary and holographic princinple, to be compared to currently dicussed nonlocal and acausal parallel world models.[3,13]

XI. Acknowledgements

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