# Examining a simpler version of a fifth force, using variant of Dilaton model and Padmanabhan Inflaton scalar field in Early universe conditions

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Abstract
On page 17 of a book on Modified Gravity by Baojiu Li and Kazuya Koyama there is a discussion of how to obtain a Fifth force by an allegedly non relativistic approximation with a force proportional to minus the spatial derivative of a scalar field. If the scalar field say for an inflaton , as presented by **Padmanabhan** only depends upon time, of course this means no scalar field contributing to a fifth force Our modest proposal in the neighborhood of Planck time is to turn the time into being equal to r/[ constant times c]. This in the neighborhood of Planck time so as to have in this small time interval, a symmetry breaking regime where we could perhaps specify a fifth force as to breaking down a causal barrier as to initiating a start to inflationary expansion. For the scalar field itself, we initially have this r dependence in place of time, whereas our scalar field, and resultant treatment of an effective potential may allow for a transition from a presumed stationary state to inflation This of course is presuming that there is, in all of our work a huge initial degree of freedom which would break down.

## I. Start off with the following from [1] [2] with an assumed value as stated

$$
\begin{aligned}
& a(t) = a_{initial} t^{\nu} \\
& \Rightarrow \phi = \ln\left(\sqrt{\frac{8\pi G V_0}{\nu\cdot(3\nu-1)}}\cdot t\right)^{\sqrt{\frac{\nu}{16\pi G}}} \\
& \Rightarrow \dot{\phi} = \sqrt{\frac{\nu}{4\pi G}}\cdot t^{-1} \qquad\qquad (I) \\
& \Rightarrow \frac{H^2}{\dot{\phi}} \approx \sqrt{\frac{4\pi G}{\nu}}\cdot t \;\; \cdot T^4 \cdot \frac{(1.66)^2\cdot g_*}{m_P^2} \approx 10^{-5}
\end{aligned}
$$

This of course makes uses of

$$
H = 1.66\sqrt{g_*}\cdot\frac{T_{temperature}{}^2}{m_P} \qquad (2)
$$

We will make the following calculation [3][4] where we start off with [3] , page 19 that

$$
A(\phi) = 1 + \frac{\phi^2}{2m_S} = 1 + \frac{A_2\phi^2}{2m_P} = 1 + \frac{\phi^2}{2\tilde{\beta}m_P} \qquad (3)
$$

Whereas

$$
V_0 = \left(\frac{.022}{\sqrt{qN_{efolds}}}\right)^4 = \frac{\nu(\nu-1)\lambda^2}{8\pi G m_P^2} \qquad (4)
$$

We can then set the coefficient $\lambda$ as a dimensionless parameter which can be calculated by Eq. (4).

And then we close this with the input from [3], page 17 as looking at the Chamelon mechanism for fifth force as

$$F_{5th-force} = -\frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \qquad (5)$$

Here is the thing. If the scalar field were solely defined in terms of Eq.(1) we would only have a time dependence, meaning that we would have Eq. (5) as equal to zero. We will make a Pre Planckian to Planckian regime approximation where this is not true

## II. How we can have a Pre-Planckian to Planckian regime of space-time so Eq. (5) for fifth force is not zero

To do this we will assume in an initial "bubble' of space-time that we can make the initial approximation of, assuming c is the speed of light, and r is a radial spatial dimension of

$$t = \frac{r}{\varpi c} \qquad (6)$$

If so, then Eq. (5) will yield a radial force component which we will write as

$$F_{5th-force} = -\frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \approx -\frac{\tilde{\beta}}{2m_P r}\cdot\sqrt{\frac{\nu}{\pi G}} \qquad (7)$$

We will discuss next what this non zero value of a fifth force would have to do with the nearly infinite degrees of problem next

## III. Interpreting the value of the force assumed in terms of Ehrenfests theorem[5]

From Gasiorowitz, [5]

$$F = \frac{d\left\langle p\right\rangle}{dt} = -\left\langle \frac{dV}{dr}\right\rangle_t \qquad (8)$$

We can interpret this in our situation as leading to

$$\left\langle p\right\rangle = -\frac{\tilde{\beta}}{2m_P}\cdot\sqrt{\frac{\nu}{\pi G}}\cdot\frac{\ln t}{\varpi c} \qquad (9)$$

For sufficiently small time step, t, this would be leading to using a simple version of the uncertainty principle, [5]

$$
\begin{aligned}
&If \langle p \rangle \approx \Delta p \approx \frac{\tilde{\beta}}{2m_P} \cdot \sqrt{\frac{\nu}{\pi G}} \cdot \frac{\left|\ln \varepsilon^{+}\right|}{\varpi c} \\
&\Delta p \Delta x \approx \hbar \Rightarrow \Delta x \approx \frac{\hbar}{\frac{\tilde{\beta}}{2m_P} \cdot \sqrt{\frac{\nu}{\pi G}} \cdot \frac{\left|\ln \varepsilon^{+}\right|}{\varpi c}} \le l_P
\end{aligned} \tag{10}
$$

Meaning that we would have increasingly high momentum , leading to enormous energy values, for sufficiently small time say smaller than Planck time

## IV. Relationship to energy values, and also the degrees of freedom initially

In an earlier paper, we have the following value for initial mass [6]

$$
\begin{aligned}
M &= \sqrt{\sqrt{g_*} \cdot \frac{1.66\hbar}{64\pi^2 m_P G^2 k_B^2}} \cdot \sqrt{\frac{t}{\gamma}} \sqrt{N_{Gravitons}} \cdot m_{Planck} \\
&\xrightarrow[Planck-Units]{} \approx \sqrt[4]{g_*} \cdot \sqrt{\frac{1.66}{64\pi^2}} \cdot m_{Planck} \approx \sqrt{N_{Gravitons}} \cdot m_{Planck} \\
&\approx 10^{60} \cdot m_{Planck}
\end{aligned} \tag{11}
$$

If so then the strange situation we have would be resolvable if

$$
\sqrt[4]{g_*} \cdot \sqrt{\frac{1.66}{64\pi^2}} \approx 10^{60} \tag{12}
$$

i.e. the initial degrees of freedom, would be a staggering value of about

$$
g_* \approx 10^{240} \cdot \left(\frac{64\pi^2}{1.66}\right)^2 \approx 10^{240} \times 144791 \propto 10^{245} \tag{13}
$$

Why is this important. Again by [6] we obtained that

$$
\begin{aligned}
&m_{graviton} \approx 10^{-60} m_P \Rightarrow N_{Gravitons} \approx 10^{120} \\
&\Rightarrow N_{Gravitons} \approx 10^{120} \approx S_{entropy} \\
&\Leftrightarrow g_* \approx 10^{240} \cdot \left(\frac{64\pi^2}{1.66}\right)^2 \approx 10^{240} \times 144791 \propto 10^{245}
\end{aligned} \tag{14}
$$

If we are using Planck Values, what we have is that the degrees of freedom , independent of assumed entropy values will commence to have an enormous value for M, and if we are using in Planck units that E , energy , is the same as mass, we are stating that our construction will be leading to for high degrees of freedom

This is directly due, if we are assuming a non zero fifth force, due to an initial value of $t = \frac{r}{\varpi c}$ that the value of Eq. (5) would be a large negative value, and if we are correct this substitution into Eq. (5) for an inflaton we would write as

$$\phi\left(\frac{r}{\varpi c}\right) = \sqrt{\frac{\nu}{4\pi G}} \ln\left(\sqrt{\frac{8\pi G V_0}{\nu(\nu-1)}} \cdot \left(\frac{r}{\varpi c}\right)\right) \qquad (15)$$

We will next discuss the meaning and comments as to the fifth force as we see it in terms of the Dilaton model

# V. Dilaton model and extension beyond General Relativity

In [3], page 17, the following is given as a NON relativistic geodestic equation for a 'test particle'

$$\ddot{\vec{x}} = -\vec{\nabla}\Psi - \frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \qquad (16)$$

The first term has a gravitational potential $\Psi$. The second term involves the fifth force. What we have assumed in this Pre Planck to Planck regime is that we are neglecting, in this $\Psi$. In a word for Pre Planck to Plank physics what we are assuming is

$$\ddot{\vec{x}} = -\vec{\nabla}\Psi - \frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \xrightarrow[\Pr e-Planck]{} \ddot{\vec{x}} = -\frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \qquad (17)$$

The assumption is for our idea the following

$$\begin{aligned}
&-\vec{\nabla}\Psi \xrightarrow[\Pr e-Planck]{} 0 \\
&-\frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \xrightarrow[\Pr e-Planck]{} NOT \quad zero \\
&t \xrightarrow[\Pr e-Planck]{} t = \frac{r}{\varpi c} \\
&t \xrightarrow[Planck]{} t \neq \frac{r}{\varpi c} \\
&-\frac{\tilde{\beta}\cdot\left(\vec{\nabla}\phi\right)}{m_P} \xrightarrow[Planck]{} Very-small-value \\
&-\vec{\nabla}\Psi \xrightarrow[Planck]{} Not-zero
\end{aligned} \qquad (18)$$

In addition as far as the term in Eq. (4), this also is tied into the following comparison[1][2][3][4]

$$V(\phi) = V_0 \exp\left(-\frac{\lambda\phi}{m_P}\right) \leftrightarrow V_0 \exp\left(-\sqrt{\frac{16\pi G}{\nu}} \cdot \phi\right) \qquad (19)$$

In the regime of Pre Planck physics, we are presuming that Eq. (5) would be enormous, whereas the fifth force as we are describing it here for Plank regime and beyond would be extremely small, and the Gravitational physics term due to a gravitational potential $\Psi$ .would predominate in Eq(16).

# VI. Review and summary, before discussion of Gravimagnetism

The idea in a word is to assume, via a deviation from usual relativity and also Newtonian physics the existence of a fifth force which in the Pre Planckian to Planckian regime may have a cache as far as developing conditions for a very large initial degrees of freedom value,

We are considering what if Eq. (5) and Eq. (6) insert fifth force physics into cosmology in a convincing manner

What has to be determined are experimental verifications of Eq, (15) and Eq. (16). Otherwise what we are doing is not going to have any experimental falsifiability

Furthermore in this is the assumption put in as far as a non singular start to the expansion of the Universie.

Some sort of experimental verification of both these details is recommended.

Finally the model included as far as [7] and [8] need to be looked at as well

# VII. Gravimagnetism as a wrap up and concluding remarks

We will conclude with a discussion of Gravimagnetism and its possible links to this problem [9]. Whereas on page 48 of [9]

$$\begin{aligned} &\frac{d\vec{v}}{dt} \equiv -grad\phi + 2\vec{\Omega}\times\vec{v} \\ &\leftrightarrow Lorentz - force \\ &= \vec{K} = q\cdot\left(\vec{E} + \frac{\vec{v}}{c}\times\vec{B}\right) \end{aligned} \quad (20)$$

In this case, the Electromagnetic correspondences is exact whereas the Einstein equations result of the first line of Eq. (20) is approximate

What we are indicating is that in the Pre Planck regime of space-time that what is actually an imprecise linearized

$$\frac{d\vec{v}}{dt} \equiv -grad\phi + 2\vec{\Omega}\times\vec{v} \quad (21)$$

Is in this case actually close to being precise whereas we make t he following approximations, namely in the Pre Planckian regime we will actually have

$$\frac{d\vec{v}}{dt} \equiv -grad\phi + 2\vec{\Omega}\times\vec{v} \xrightarrow[\Pr e-Planckian]{} \frac{d\vec{v}}{dt} \equiv -grad\phi \approx -\partial_r\phi \quad (22)$$

Whereas we have the time component of the term

$$\phi(t) \xrightarrow[\Pr e-Planckian]{} \phi\left(\frac{r}{\varpi c}\right) \tag{23}$$

The feasibility of Eq. (22) and Eq. (23) as well as the match up given in Eq(21) and its linkages to Eq(20) need to be confirmed in experimental vetting of data sets

If this is done, then the following Graviton condensate relationship as argued by the author before, should also be examined as far as experimental verification , especially if the initial configuration of the Universe right after the Pre Planck physics written out is amendable to black holes in the start of inflation [10]

$$\begin{aligned}
m &\approx \frac{M_P}{\sqrt{N_{gravitons}}} \\
M_{BH} &\approx \sqrt{N_{gravitons}} \cdot M_P \\
R_{BH} &\approx \sqrt{N_{gravitons}} \cdot l_P \\
S_{BH} &\approx k_B \cdot N_{gravitons} \\
T_{BH} &\approx \frac{T_P}{\sqrt{N_{gravitons}}}
\end{aligned} \tag{24}$$

Having a change in initial conditions from Pre Planckian physics to Planckian physics would be enough to initiate shifting from Eq. (20), Eq. (21) and Eq. (22) to initiate the beginning of black hole physics, if we are correct and Eq. (24) being applied as well as if m in Eq. (24) is actually the mass of a graviton

If so, by Novello [11] we then have a bridge to the cosmological constant as given by

$$m_g = \frac{\hbar \cdot \sqrt{\Lambda}}{c} \tag{25}$$

In a word, the next step to ascertain would be how Eq. (23), as given breaks down, and we have then application of Eq. (24) with m set with m becoming the mass of a graviton as given in Eq. (25)

Confirming these details should be the object of future research as can also be seen in [11]. In addition we have the argument given in [12] as to using another procedure as to the choice of the Starobinsky potential as well as the Adler, Bazin and Shiffer as to the use of radial acceleration as a way of confirming the cosmological constant,

The way indicated in [12] may be a way to fix the value of m, after determining M, as an input into Eq, (24) and then from there ascertain the right hand side of Eq. (25) whereas in [6], we will be determining the right hand side of Eq. (25), namely $\Lambda$ and then after doing that, assuming Eq. (25) to work backwards into the M of Eq. (24)

That is how to reconcile the [6] and [12] references whereas we will be using this current document to ascertain the existences of a Fifth force which would be a bridge between Pre Planckian to Planckian physics,. Finally though what is implicitly assumed is [13] which is an application of Klauder enhanced quantization

Finally is the imponderable, i.e. the generalization of Penrose CCC theory which is in [6] which is a generalization of what is in Penrose single universe recycling of universes which may be seen in [14]

All these steps need to be combined and rationalized Three different pieces

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