A NEW MODEL

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Abstract: I examine a slight modification to the so-called Higgless models that allows for a real Higg's particle and some cosmological constant that varies over time via vacuum decay.

In the case when we have two world sheets, one with positive tension at y = 0 and a second one at y = d with sheets satisfies

$$\left(\frac{1}{a^2}\Box^{(4)}\bar{h}_{\mu\nu}\right)^{(\pm)} = -\sum_{\sigma=\pm} 16\pi G^{(\sigma)}\left(T_{\mu\nu} - \frac{1}{3}\gamma_{\mu\nu}T\right)^{(\sigma)} \pm \frac{16\pi G^{(\pm)}}{3}\frac{\sinh(d/\ell)}{e^{\pm d/\ell}}\gamma_{\mu\nu}T^{(\pm)},$$

where the plus and minus refer to quantities on the wall with positive and with negative tension respectively. We thus derive

$$G^{(\pm)} = \frac{G_5\ell^{-1}e^{\pm d/\ell}}{2\sinh(d/l)}$$

giving us the shadow world/matter world Newton's constant in BD format. The induced metric is thus,

$$\bar{h}_{\mu\nu} = -16\pi G\frac{1}{\Box^{(4)}}\left(T_{\mu\nu} - \frac{1}{2}\gamma_{\mu\nu}T\right),$$

where

$$G = \ell^{-1}G_5$$

is the 4 Dimensional Newton's constant on our sheet. The motivation for such a model is as follows:

The vacuum energy density should contribute both to gravity and the Cosmological constant since

$$R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R - \Lambda g_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

Observation tells us

$$|\rho_{vac}| < 10^{-29} \ g/cm^3 \sim 10^{-47} \ GeV^4 \sim 10^{-9} \ erg/cm^3$$

and

$$|\Lambda| < 10^{-56} cm^{-2}$$

The classical Higg's potential is given by

$$V(\phi) = V_0 - \mu^2 \phi^2 + \lambda \phi^4 \quad \langle 0|\phi|0\rangle = v$$

With the known range of around 125 GeV. Where V is 250 GeV for the EW scale, we get when V=0

$$\rho_{\text{vac}}^{\text{SSB}} = -\frac{\mu^4}{4\lambda} \sim -\lambda v^4 \sim -10^5 \, \text{GeV}^4 \quad \rho_{\text{vac}}^{\text{OBS}} \sim 10^{-47} \, GeV^4$$

$$|\rho_{\text{vac}}^{\text{SSB}}| \sim 10^{56} \rho_{\text{vac}}^{\text{OBS}}.$$

This still leaves us a problem when it comes to the contribution of the quantum vacuum. The simplest solution is to propose a solution along similar lines to the so-called Higgless models(Kaplan and Sundrum 2005), but in this case two Higg's modes exist, one in the shadow world sheet and the other in our world sheet. You get the same cancellation of the quantum expectation value for the vacuum but in a Finite temperature metastable state that has a small cosmological constant.

We know from recent searches that our Higg's lies at 125 GeV. The EW scale around 250 GeV as a primary is canceled by the shadow world sheet's negative Higg's of 125 leaving our Higg's value at 125 positive. This is in a metastable range which means further vacuum decay can take place. The EW scale itself is canceled by a shadow world sheet negative 250 GeV primary value which then removes any contribution via the EW scale to the quantum vacuum expectation value. The Quark-Gluon scale is itself canceled by a similar effect.

This leaves only the possible decay states of the Higg's as the origin of any cosmological constant. We know it's maximum value from observation and can further constrain it via the above equations to less that 10^{-5} GeV with observation further lowing it to less than 10^{-9} GeV. We then need a mechanism that keeps the metastable vacuum nearly stable with an increase in decay over time. But before that we will look at gravity a bit closer.

Starting with the Einstein equations(1) defined by

$$R_{MN} - \frac{1}{2} g_{MN} R = \frac{8\pi G}{c^4} T_{MN}.$$

In general relativity the gravitational force is represented by a Riemannian metric of curved space-time manifold M

$$\left(\frac{\partial}{\partial s}\right)^2 = g^{MN}(x) \frac{\partial}{\partial x^M} \otimes \frac{\partial}{\partial x^N}.$$

defined by the tensor product of two vector fields

$$E_A = E_A^M(x) \frac{\partial}{\partial x^M} \in \Gamma(TM)$$

Where

$$\left(\frac{\partial}{\partial s}\right)^2 = \eta^{AB} E_A \otimes E_B.$$

The vector field

$$E_A \in \Gamma(TM)$$

are the smooth sections of tangent bundle

$$TM \to M$$

which are dual to the vector space

$$E^A = E_M^A(x) dx^M \in \Gamma(T^*M), \text{ i.e., } \langle E^A, E_B \rangle = \delta_B^A.$$

If we allow that that a spin-two graviton might arise as a composite
of two spin-one vector fields(2) whereby we find the tensor product under the

relationship

$$(1 \otimes 1)_S = 2 \oplus 0.$$

We then have the requirement of general covariance that gravity couples universally to all kinds of energy. Therefore the vacuum energy

$$\rho_{\rm vac} \sim M_P^4$$

will induce a highly curved spacetime whose curvature scale R would be

$$\sim M_P^2$$

we know that QFT is well-defined as ever in the presence of the vacuum energy because the background space=time still remains flat or at least behaves as if it was flat. So while any field for fundamental particles in Standard Model cannot be written as the tensor product of other two fields only composites can it would seem the most likely case for our composite would be two parts that unite and via addition of fields cancel part of

$$\rho_{\rm vac} \sim M_P^4$$

The before mentioned mechanism solves that cancellation problem. But we still then have to find the two part carrier. One could propose gravitons and anti-gravitons or one can think in terms of graviphotons. In either case you have a quantum carrier for gravity. However, the zero-trace quadrupole moment tensor of a system of charges is defined as

$$\nabla^2 V - \frac{1}{c^2}\frac{\partial^2 V}{\partial t^2} = 4\pi G\rho$$

The scalar potential is given by

$$V = -N\left(i\left(\frac{1}{kr} - \frac{3}{(kr)^3}\right) - \frac{3}{(kr)^2}\right)(3Cos^2\theta - 1)e^{i(kr-\omega t)}$$

With the following relations in Maxwell format

$$B = \frac{\omega}{c^2}(r \times \nabla V) \qquad E = \frac{ic^2}{\omega}(\nabla \times B)$$

By substituting the relations the value of n can be determined

$$\varepsilon_0 = -1/(4\pi G)$$

the result yields

$$B_\phi = \frac{6N\omega}{c^2}\left[\left(\frac{1}{kr} - \frac{3}{(kr)^3}\right)i - \frac{3}{(kr)^2}\right]\left[Cos(\theta)Sin(\theta)\right]e^{i(kr-\omega t)}$$

$$E_r = 6Nk\left[\left(\frac{-3}{(kr)^3}\right)i - \frac{1}{(kr)^2} + \frac{3}{(kr)^4}\right]\left[3Cos^2(\theta)-1\right]e^{i(kr-\omega t)}$$

$$E_\theta = 6Nk\left[\left(\left(\frac{1}{kr}\right) - \frac{6}{(kr)^3}\right)i + \frac{6}{(kr)^4} - \frac{3}{(kr)^2}\right]\left[Cos(\theta)Sin(\theta)\right]e^{i(kr-\omega t)}$$

where: $N = -G\ m\ s^2\ k^3$, G = Grav const., m = mass, s = Dipole length, k = Wave number

in the limit

$(kr \to 0)$.

Now if we postulate that this field is itself split into two components then the resultant is a simple dipole field with conventional EM Maxwell equations. One set of equation would involve negative energy and the other positive energy. This offers a way to test this idea out involving a search for an em signal from a predictable origin point where quadrapole radiation should be generated at about half the amplitude to be expected of the normal quadrapole gravity wave detection method, but at the same frequency of the expected quadrapole gravity field.

We shall then return to the origin of the cosmological constant and the issue of the metastable state of the vacuum. One area we should be looking for is a decay of the Higg's into two photons of 31 to 32 GeV with a missing mass in the event of around 62 to 63 GeV. The two photons would be at the upper end of QED stability and as such, when combined with the extra missing mass term result in an unballance of the canceling of the quantum vacuum's expectation value resulting in an increase of vacuum pressure over time. This vacuum pressure changes results in an evolving cosmological constant.

The missing mass would be the long sought dark matter formed out of an actual stable minimum that is not coupled to the EW scale and as such does not radiate. Such a free stable Higg's boson would have only one means by which we can detect it, it's gravity signature.

The RS model, which this model is based upon, circumvents the need of compactifying all but the three observed spatial dimensions by including a bound state of the massless graviton on the brane(1). At distances defined by

$r \gg \mathrm{L}$,

the model implies a correction to the Newtonian gravitational potential of a body of mass M. This correction is given by

$$U_{\mathrm{RS}} = -k\frac{GM}{r}\left(\frac{\mathrm{L}}{r}\right)^2,$$

where G is the Newtonian constant of gravitation, and k can assume different values depending on the schemes of regularization adopted(2). This value can be derived out of the before mentioned Newtonian formula. The local and global canceling of the ZPF modes tends to constrain this itself, except in the case of decayed Higg's states with the uncoupling of the cancelation effect so that Dark Matter in effect should display the value of K, thus displaying a slight correction to the standard Newtonian. It is through this avenue that the effects of the other world sheet can be detected.

References

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2.) E. Jung, S. H. Kim, and D. K. Park, Nucl. Phys. B 669, 306 (2003).