STRETCHED NEUTRINOS, AND THE SUPPOSED LINKAGE TO GRAVITONS/ HFGW DATA SETS

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Following the discussion of George Fuller and Chad Kishimoto, in PRL, 2009, the issue of if or not a correlation exist between neutrino physics, and HFGW data sets / gravitons will be raised anew, with a particular emphasis upon what happens if the following scenario outlined by Fuller and Kishimoto arises. What if as the "universe expanded, the most massive of these states slowed down in the relic neutrinos, stretching them across the universe". If an initial close correlation between Gravition data sets/ HFGW and relic neutrinos exists in the beginning, do we have in any case a situation where there is a corresponding 'stretch out' of gravitons? If so, what would this say about the relevant requirements for graviton/ HFGW detectors?

1.1 What Can Be Said about Gravitational wave Density and its Detection?

We will put a first principle introduction. as to what can be said about gravitational wave density and its detection? It is useful to note that normalized energy density of gravitational waves, as given by Maggiore [1]

$$\Omega_{gw} \equiv \frac{\rho_{gw}}{\rho_c} \equiv \int_{f=0}^{f=\infty} d(\log f) \cdot \Omega_{gw}(f) \Rightarrow h_0^2 \Omega_{gw}(f) \cong 3.6 \cdot \left[\frac{n_f}{10^{37}}\right] \cdot \left(\frac{f}{1kHz}\right)^4 \quad (1)$$

Where n_f is a frequency based count of gravitons per unit cell of phase space. In terms of early universe nucleation, the choice of n_f may also depend upon interaction of gravitons with neutrinos. The supposition is, that eventually , Eq. (1) above could be actually modified with a change of

$$n_f \propto n_f[graviton] + n_f[neutrinos] \quad (2)$$

And also a weighted average of neutrino-graviton coupled frequency $\langle f \rangle$, so that for detectors

$$h_0^2 \Omega_{gw}(f) \cong \frac{3.6}{2} \cdot \left[\frac{n_f[graviton] + n_f[neutrino]}{10^{37}}\right] \cdot \left(\frac{\langle f \rangle}{1kHz}\right)^4 \quad (3)$$

The supposition to be investigated will be what if Eq (3) were true, how to actually measure it, and some consequences, especially if Fuller and Kishimoto [2], in PRL, 2009 is legitimate. Among other things, the author is convinced that the spread out of the neutrino, as outlined by Fuller and Kishimoto [2], may be one of the factors leading to the graviton having, in later times a small mass, perhaps on the order of $m_{graviton} \propto 10^{-65}$ grams. The consequences of such a small rest mass are in figure 1

.1.2 Consequences, which the author believes should be investigated

As brought up in Beckwith [3] (2009), there is a signatory effect of gravitons which may have macro consequences, i.e. that of Gravitons contributing to the re acceleration of the Universe. In a re do of Alves et al. [4] (2009) treatment of the Jerk calculation , i.e. re acceleration for the universe one billion years ago, Beckwith obtained for a brane world treatment of the Friedman equation leading to the following behavior Assume X is red shift, Z. q(X) is De - Celeration . Here we have a graph of de celeration parameter due to small $m_{graviton} \propto 10^{-65}$ grams,, with q(Z) defined as below

$$q = -\frac{\ddot{a}a}{\dot{a}^2} \qquad (4)$$

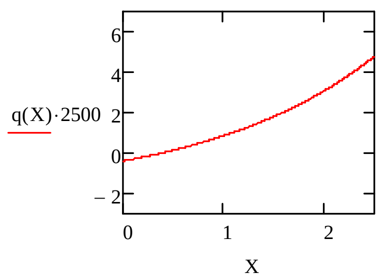

Figure 1 : Re duplication of basic results of Alves, et al. [4] , using their parameter values, with an additional term of C for 'Dark flow' added, corresponding to one KK additional dimensions.

The treatment of the jerk calculation follows what Beckwith [3] did for a brane world plot and analysis of the jerk, q(Z), with Z set = X in the calculation above. This assumes that a small mass exists for the graviton, and that this is for a brane world treatment of the Friedman equation, along the lines of writing the density of a brane world having

$$\rho \equiv \rho_0 \cdot \left(\frac{a_0}{a}\right)^3 - \left[\frac{m_g c^6}{8\pi G\hbar^2}\right] \cdot \left(\frac{a^4}{14} + \frac{2a^2}{5} - \frac{1}{2}\right) \qquad (5)$$

The supposition that the author is entertaining, is that the mass of the graviton is partly due to the stretching alluded to by Fuller and Kishimoto [1] , a supposition the author is investigating for a slight modification of a joint KK tower of gravitons as given by Maartens,[5].,for DM which the author believes is promising. I.e. what if the following actually occurred? Assume that the stretching of neutrinos would lead to the KK tower of gravitons is

$$m_n(Graviton) = \frac{n}{L} + 10^{-65} \text{ grams}, \tag{6}$$

Assume that with stretching of the neutrino, and graviton neutrino coupling with zeroth order value of $m_0(Graviton) \approx 10^{-65}$ grams as a consequence **of at least a few** of the neutrino-gravitons obeying density fluctuation modified , according to Bashinsky [6] $\left[1 - 5\cdot(\rho_{neutrino}/\rho) + \vartheta\left([\rho_{neutrino}/\rho]^2\right)\right]$ according to Bashinsky [6] (2005), as well as having equivalent neutrino-graviton wave lengths becomes, instead the same order of magnitude as the matter wave values of neutrinos, with, initially

$$m_{graviton}\Big|_{RELATIVISTIC} < 4.4\times10^{-22}\,h^{-1}eV/c^2$$
$$\Leftrightarrow \lambda_{graviton} \equiv \frac{\hbar}{m_{graviton}\cdot c} < 2.8\times10^{-8}\,meters \tag{7}$$

A few select gravitons, coupled to almost infinite wave length stretched neutrinos would lead to Eq(7) , if they were sufficiently large, as of

$$\lambda_{graviton} \equiv \frac{\hbar}{m_{graviton}\cdot c} < 10^4\,meters \text{ or larger} \tag{8}$$

2 Conclusions, to be investigated. Further Research questions to look into

If Eq(8) is true for a few select neutrinos and gravitons, then the author believes that it is reasonable to assume that as up to a billion years ago, $m_{graviton} \propto 10^{-65}$ grams. If so then the derivation of Figure 1 above is plausible. The problem the author is investigating is what is the consequence of Eq(8) for Eq(3). The author believes this problem is resolvable, and may imply a linkage between DE and DM in ways richer than what is done by the Chapygin gas models which are now currently a curiosity, experimentally.

References

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6 R. Maartens, , "Brane-World Gravity (2004)", http://www.livingreviews.org/lrr-2004-7