DECELERATION PARAMETER Q(Z) IN FIVE DIMENSIONS, AND CAN A PARTIAL RE APPEARANCE OF QUINESSENCE $\phi(t)$ PLAY A ROLE IN AN INCREASE IN RE- ACCELERATION AT Z ~. 423?

ANDREW WALCOTT BECKWITH

American Institute of Beam Energy Propulsion, life member

The case for a four dimensional graviton mass (non zero) influencing reacceleration of the universe in five dimensions is stated, with particular emphasis upon if five dimensional geometries as given below give us new physical insight as to cosmological evolution. One noticeable datum, that a calculated inflaton $\phi(t)$ re-emerged after fading out in the aftermath of inflation. The inflaton is a contributing factor to, with non zero graviton mass, in re acceleration of the universe a billion years ago. The inflaton also may be the source of re acceleration of the universe, especially if the effects of a re emergent inflaton are in tandem with the appearance of macro effects of a small graviton mass, leading to a speed up of the rate of expansion of the universe one billion years ago, at red shit value of Z ~ .423

1 Introduction

1.1 What can be said about gravitational wave density value detection?

We will start with a first-principle introduction to detection of gravitational wave density using the definition given by Maggiore [1]

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

where n_f is the frequency-based numerical count of gravitons per unit phase space. The author suggests that n_f may also depend upon the interaction of gravitons with neutrinos in plasma during early-universe nucleation, as modeled by M. Marklund *et al* [2]. Having said that, the question is, what sort of mechanism is appropriate for considering macro affects of gravitons, and the author thinks that he has one, i.e. reacceleration of the universe, as far as a function of graviton mass, i.e. what Beckwith[3] did was to make the following presentation. Assume Snyder geometry and look at use of the following inequality for a change in the HUP, [4]

$$\Delta x \geq \left[(1/\Delta p) + l_s^2 \cdot \Delta p\right] \equiv (1/\Delta p) - \alpha \cdot \Delta p \qquad (2)$$

and that the mass of the graviton is partly due to the stretching alluded to by Fuller and Kishimoto,[5] a supposition the author[3] is investigating for a modification of a joint KK tower of gravitons, as given by Maartens[6] for DM. Assume the stretching of early relic neutrinos that would lead to the KK tower of gravitons--for when $\alpha < 0$, is[4],

$$m_n(Graviton) = \frac{n}{L} + 10^{-65} \text{ grams} \tag{3}$$

Note that Rubakov[7] writes KK graviton representation as, after using the following normalization $\int \frac{dz}{a(z)} \cdot [h_m(z) \cdot h_{\tilde{m}}(z)] \equiv \delta(m - \tilde{m})$ where J_1, J_2, N_1, N_2 are different forms of Bessel functions, to obtain the KK graviton/ DM candidate representation along RS dS brane world

$$h_m(z) = \sqrt{m/k} \cdot \frac{J_1(m/k) \cdot N_2([m/k] \cdot \exp(k \cdot z)) - N_1(m/k) \cdot J_2([m/k] \cdot \exp(k \cdot z))}{\sqrt{[J_1(m/k)]^2 + [N_1(m/k)]^2}} \tag{4}$$

This Eq. (4) is for KK gravitons having a TeV magnitude mass $M_Z \sim k$ (i.e. for mass values at .5 TeV to above a TeV in value) on a negative tension RS brane. What would be useful would be managing to relate this KK graviton, which is moving with a speed proportional to H^{-1} with regards to the negative tension brane with $h \equiv h_m(z \to 0) = const \cdot \sqrt{\frac{m}{k}}$ as an initial starting value for the KK graviton mass, before the KK graviton, as a 'massive' graviton moves with velocity H^{-1} along the RS dS brane. If so, and if $h \equiv h_m(z \to 0) = const \cdot \sqrt{\frac{m}{k}}$ represents an initial state, then one may relate the mass of the KK graviton, moving at high speed, with the initial rest mass of the graviton, which in four space in a rest mass configuration would have a mass lower in value, i.e. of $m_{graviton}(4 - Dim \quad GR) \sim 10^{-48} eV$, as opposed to $M_X \sim M_{KK-Graviton} \sim .5 \times 10^9 eV$. Whatever the range of the graviton mass, it may be a way to make sense of what was presented by Dubovsky et.al. [8] who argue for graviton mass using CMBR measurements, of $M_{KK-Graviton} \sim 10^{-20} eV$ Also Eq. (5) will be the starting point used for a KK tower version of Eq. (6) below. So from Maarten's [10] 2005 paper,

$$\dot{a}^2 = \left[\left(\frac{\tilde{\kappa}^2}{3} \left[\rho + \frac{\rho^2}{2\lambda} \right] \right) a^2 + \frac{\Lambda \cdot a^2}{3} + \frac{m}{a^2} - K \right] \tag{5}$$

Maartens [10] also gives a 2nd Friedman equation, as

$$\dot{H}^2 = \left[-\left(\frac{\tilde{\kappa}^2}{2} \cdot [p+\rho] \cdot \left[1 + \frac{\rho^2}{\lambda} \right] \right) + \frac{\Lambda \cdot a^2}{3} - 2\frac{m}{a^4} + \frac{K}{a^2} \right] \qquad (6)$$

Also, if we are in the regime for which $\rho \cong -P$, for red shift values z between zero to 1.0-1.5 with exact equality, $\rho = -P$, for z between zero to **.5.** The net effect will be to obtain, due to Eq. (6)**,** and use $a \equiv [a_0 = 1]/(1+z)$. As given by Beckwith[3]

$$q = -\frac{\ddot{a}a}{\dot{a}^2} \equiv -1 - \frac{\dot{H}}{H^2} = -1 + \frac{2}{1 + \tilde{\kappa}^2[\rho/m] \cdot (1+z)^4 \cdot (1+\rho \ \ /2\lambda)} \approx -1 + \frac{2}{2+\delta(z)} \qquad (7)$$

Eq. (6) assumes $\Lambda = 0 = K$, and the net effect is to obtain, a substitute for DE, by presenting how gravitons with a small mass done with $\Lambda \neq 0$, even if curvature **K** =0

2 Consequences of small graviton mass for reacceleration of the universe

In a revision of Alves *et. al,* [9] Beckwith[3] used a higher-dimensional model of the brane world and Marsden[6] KK graviton towers. The density ρ of the brane world in the Friedman equation as used by Alves *et. al*[9] is use by Beckwith[3] for a non-zero graviton

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

I.e. Eq. (6) above is making a joint DM and DE model, with all of Eq. (6) being for KK gravitons and DM, and 10^{-65} grams being a 4 dimensional DE. Eq. (5) is part of a KK graviton presentation of DM/ DE dynamics. Beckwith[11] found at z ~ **. 4**, a billion years ago, that acceleration of the universe increased, as shown in Fig. 1.

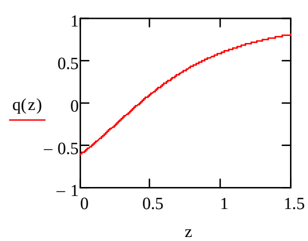

Fig. 1: Reacceleration of the universe based on Beckwith [3] **(note that q < 0 if z <.423)**

Conclusion. We need to determine if GW/ Gravitons can do double duty as DM / DE candidates in cosmic evolution.

Beckwith [24,25,26], investigated if gravitons could be a graviton gas for a substitute for a vacuum energy, as well as considered a suggestion by Yurov [27], of double inflation which if verified would justify Fig 1 above. He looks forward to presenting elaborations of these ideas in fore coming conferences in 2010. It would be highly significant if semi classical treatments of the graviton can be shown to be consistent with Fig 1 above.

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