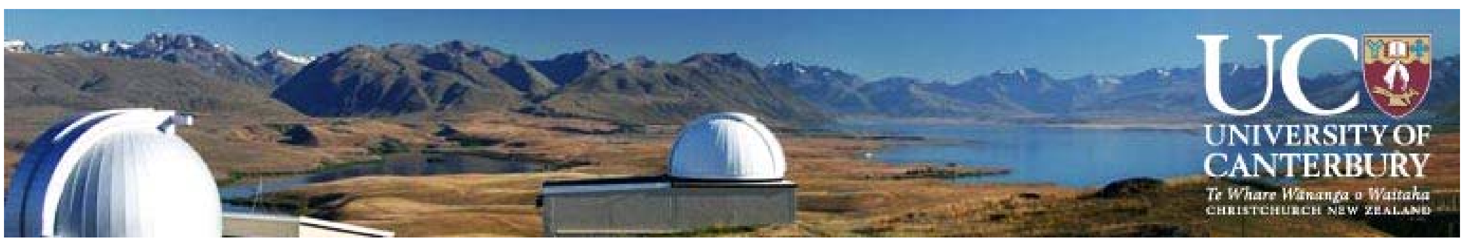
Applications of Euclidian Snyder geometry to space time physics & Deceleration parameter (DE replacement?) Analysis of linkage between 1st, 2nd inflation?

For ACGRG5 & Beyond Standard Model, 2010, Capetown, S.A.
Xian, PIERS 2010, PRC



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Abstract

A thought experiment: LQG or string theory as an initial space-time template for emergent gravity?

- Applications of deformed Euclidian space to questions about the role of string theory and/or LQG

- To what degree are the fundamental constants of nature preserved between different cosmological cycles?

- To what degree is gravity an emergent field that is partly/largely classical with extreme nonlinearity, or a QM/quantum field theory phenomenon?

Math – Physics representation of core issues of higher dimensional contribution

- Start off with a basic statement of strength of matter - graviton interaction, assuming KK graviton

$$\Im = -\frac{\kappa}{2} \cdot \sum_n \int d^4 x h_{uv}^n \cdot T^{uv} \sim 1/M_{PL}^2$$

The stress energy tensor comes from the standard model, and the h term is from using a KK graviton interactions model , up to the n th mode.

Has some similarity with graviton-neutrino interaction issues talked about in this PPT

Does the last slide hold if we make the following modification of a KK tower of gravitons ?

- Modification put in, as seen in later to mimic DE
- Suggestion to look at, here, is to consider what if
- $$m_n(Graviton) = \frac{n}{L} + 10^{-65}$$ grams?

Issues to raise

- 1. Is there a link between a 1st inflation, ending in 10^ - 35 seconds after big bang, and 2nd inflation commencing before 1 billion years ago ?

2. Commonality between the two ?

3. Do gravitons, with tiny mass play a role in the 1st and 2nd inflationary episodes ?

Look at A. Yurov; arXiv : hep-th/028129 v1, 19 Aug, 2002

- Claim: Exist one emergent complex scalar field . Accounts for both 1st and 2nd inflation
-

Potential in both cases chaotic inflation of the type

$$V = \overleftrightarrow{m}^2 \Phi^* \Phi$$

Mass m is for inflaton, and 2nd $\vec{m}$ expression has links to 5th dim length L

$$\vec{m} \approx \sqrt{\frac{3}{8}}_{\vec{m}} \cdot \left[\left. \sqrt{\frac{3H^2}{4\pi G}} \right|_{time \sim 10^{-35}\,\sec} + \left. \sqrt{\frac{3H^2}{4\pi G}} \right|_{time \sim 10^{-44}\,\sec} \right]$$

$$\left| \vec{m} \right| \leq \left[\frac{l^2}{4} \right]$$

Important simplification used

- From beginning of inflation, assume V potential energy is much smaller than H contribution

$$\frac{3H^2}{4\pi G} >> V(t)\Big|_{time\sim 10^{-44}\ \sec}$$

The 5th dimensional length L is for a brane theory "arc-length"

- From Roy Maarten's Brane theory work

$$dS^2\Big|_{5-\mathrm{dim}} = \frac{l^2}{z^2}\cdot\left[\eta_{uv}dx^{\mu}dx^{v} + dz^2\right]$$

Find equivalence between

- 1st , 2nd equations for Friedman relations

$$H^2 = \frac{1}{6} \cdot \left[\dot{\phi}^2 + \overleftrightarrow{m}^2 \phi^2 + \frac{M^2}{\phi^2} \right] \leftrightarrow \left(\frac{\tilde{\kappa}^2}{3} \left[\rho + \frac{\rho^2}{2\lambda} \right] \right) + \frac{m}{a^4}$$

$$\dot{H}^2 \cong \left[-2 \frac{m}{a^4} \right] \leftrightarrow \quad \dot{H} = V - 3H^2$$

Beckwith asserts there may be some reason to expect linkage between 1st and 2nd inflation

- Look at if the scalar field arises in 2nd inflation due to

$$dS^2\Big|_{5-\dim} = \frac{l^2}{z^2}\cdot\left[\eta_{uv}dx^{\mu}dx^{\nu} + dz^2\right]$$

$$\left|\overleftrightarrow{m}\right| \le \left[\frac{l^2}{4}\right]$$

$$\phi_{0,-} = \sqrt{2/3}\cdot\overleftrightarrow{m}\cdot\left[t_{1st-EXIT} \sim 10^{-35}\sec\right]$$

$$\phi_{+} = \left[\phi_{0,+}^{3} - \sqrt{3/2}\cdot\frac{3M^2 t}{\overleftrightarrow{m}}\right]^{1/3}$$

Snyder formulation of HUP

1st Basic relation

$$[q, p] = i \cdot \sqrt{1 - \alpha \cdot p^2} \Leftrightarrow \Delta q \Delta p \geq \frac{1}{2} \cdot \left| \left\langle \sqrt{1 - \alpha \cdot p^2} \right\rangle \right|$$

2nd Basic relation

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

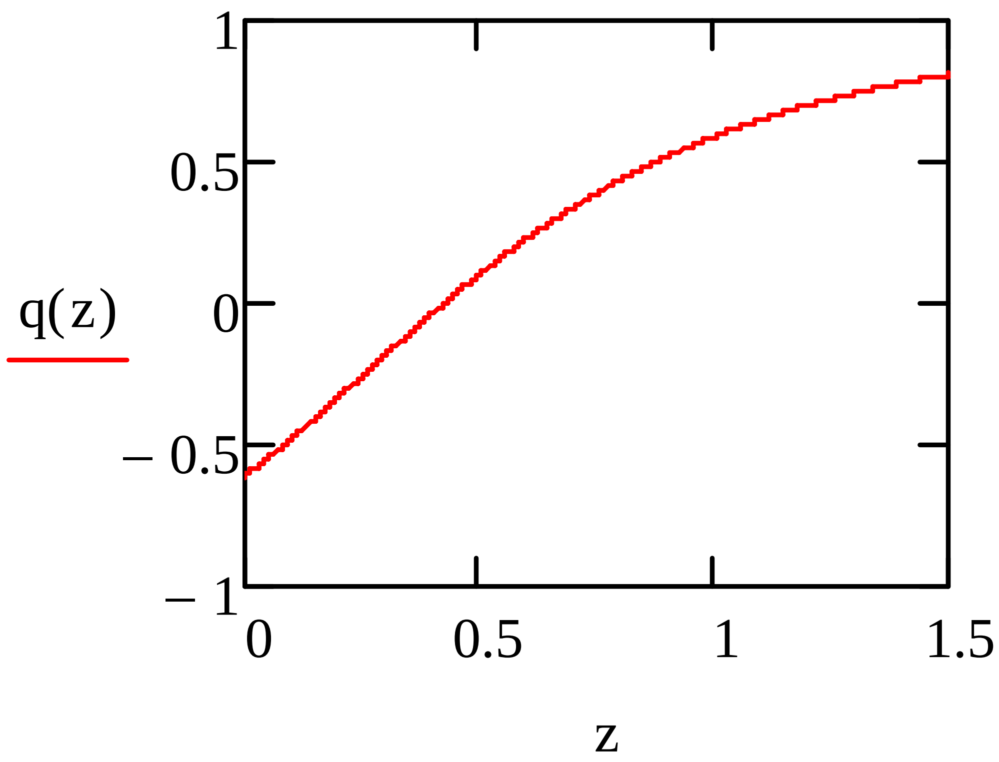
3rd Basic relation

LQG has $\alpha > 0$

Braneworld $\alpha < 0$

Jerk calculation leads to

- If we define the jerk $q = -\frac{\ddot{a}a}{\dot{a}^2}$



Assuming a brane world

Z (red shift value). Change in sign for Z ~.42 is almost one billion years ago, corresponding to reacceleration of the universe, i.e

Basic results of Alves, et al. (2009), using their parameter values, with an additional term of "dark flow" added, corresponding to one KK additional dimensions.

For brane world, the following modification of Roy Maarsten's

- KK tower assumed to have a small non-zero mass added, i.e. no zero order value for the graviton

4 – D graviton ~ 10^{-65} grams

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

For brane world, use these evolution equations

Friedman equation, subsequently modified

$$\dot{a}^2 = \left[\left(\frac{\rho}{3M_4^2} + \frac{\Lambda_4}{3} + \frac{\rho^2}{36M_{Planck}^2} \right) a^2 - \kappa + \frac{C}{a^2} \right]$$

Density equation, with non-zero graviton mass

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

For LQG, use these evolution equations

Friedman equations, assuming 'constant' momentum

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{\kappa}{3}\cdot\rho \qquad \left(\frac{\dot{a}}{a}\right)^2 \equiv \frac{\kappa}{6}\cdot\frac{p_\phi^2}{a^6} \qquad \left(\frac{\ddot{a}}{a}\right) = -\frac{2\cdot\kappa}{3}\cdot\rho$$

Density equation

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

Can neutrinos interact with Gravitons? Part 1

Bashinsky states that the density of gravitons interacting with neutrinos causes an alteration of overall GR density via

$$\left[1 - 5 \cdot \left(\rho_{neutrino} / \rho\right) + \vartheta\left(\left[\rho_{neutrino} / \rho\right]^2\right)\right]$$

Can neutrinos interact with Gravitons? Part 2

- **George Fuller and Chad Kishimoto's PRL stretched neutrino hypothesis: a neutrino could be stretched 'across the universe' leading to (if there is an interaction with gravitons):**

  A few select gravitons, coupled to almost infinite wavelength stretched neutrinos would lead to at least the following stretched graviton wave

$$\lambda_{graviton} \equiv \frac{\hbar}{m_{graviton} \cdot c} < 10^4 \, meters$$

Semiclassical interpretation of giant graviton waves?

Brought up as a way to interpret the existence of a small graviton mass, which appears to violate the QM correspondence principle (shown later)

Main motivation: a field theory limit demo that shows problems with **massive graviton field theories, and the limit**

$$m_{graviton} \to 0$$

How to measure a graviton/ GW ?

- Look at the normalized gravitational wave density function

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

- Note that n depends upon frequency and is stated to be part of the unit phase space

Infinite Quantum statistics. From the work presented in the Paris observatory, July 2009 Start with

$$Z_N \sim \left(\frac{1}{N!}\right) \cdot \left(\frac{V}{\lambda^3}\right)^N \qquad S \approx N \cdot \left(\log\left[V/N\lambda^3\right] + 5/2\right)$$

$$S \approx N \cdot \left(\log\left[V/\lambda^3\right] + 5/2\right) \qquad V \approx R_H^3 \approx \lambda^3$$

V stands for volume of nucleation regime space. “particles” nucleate from ‘vacuum’ in QM

For DM. V for nucleation is HUGE. Graviton space

V for nucleation is tiny , well inside inflation/ Therefore, the log factor drops OUT of entropy S if V chosen properly. For small V, then

$$\Delta S \approx \Delta N_{gravitons}$$

Some considerations about the partition function

Glinka (2007): if we identify $$\Omega = \frac{1}{2|u|^2 - 1}$$

- as a partition function (with u part of a Bogoliubov transformation) due to a graviton-quintessence gas, to get information theory-based entropy $S \equiv \ln \Omega$

1. Derivation by Glinka explicitly uses the Wheeler De Witt equation
2. 2. Is there in any sense a linkage of Wheeler De Witt equation with String theory results ?

PROBLEM TO CONSIDER:

Ng's result quantum counting algorithm is a **STRING theory** result.Glinka is **Wheeler De Witt equation**. **Equivalent ?**

Questions to raise.

Can we make a linkage between Glinka's quantum gas argument, and a small space version/ application of Ng's Quantum infinite statistics ?

In addition, if the quantum graviton gas is correct, can we model emergent structure of gravity via linkage between Ng particle count, and Q.G.G argument?

LQG , while using WdW up to a point, does not admit higher dimensions above 4 dimensions . String-Brane theory does

- Why is this relevant to a discussion of the LQG vs Brane theory discussion ?

Breakdown of field theory with respect to massive gravitons in limit

$$m_{graviton} \to 0$$

The massless equation of the graviton evolution equation takes the form

$$\partial_{\mu}\partial^{\mu}h_{\mu\nu} = \sqrt{32\pi G}\cdot\left(T_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu}T_{\mu}^{\mu}\right)$$

Consider what happens with a graviton mass

$$m_{graviton} \neq 0$$

From Maggiore (2008):

$$\left(\partial_{\mu}\partial^{\mu} - m_{graviton}\right)\cdot h_{\mu\nu} = \left[\sqrt{32\pi G} + \delta^{+}\right]\cdot\left(T_{\mu\nu} - \frac{1}{3}\eta_{\mu\nu}T_{\mu}^{\mu} + \frac{\partial_{\mu}\partial_{\nu}T_{\mu}^{\mu}}{3m_{graviton}}\right)$$

The mismatch between these two equations when

$$m_{graviton} \to 0$$

Is largely due to, even if graviton mass goes to zero

$$m_{graviton} h^{\mu}_{\mu} \neq 0$$

$$m_{graviton} \cdot h^{\mu}_{\mu} = -\left[\sqrt{32\pi G} + \delta^{+}\right] \cdot T^{\mu}_{\mu}$$

Try semiclassical model of graviton, as kink-anti kink pair

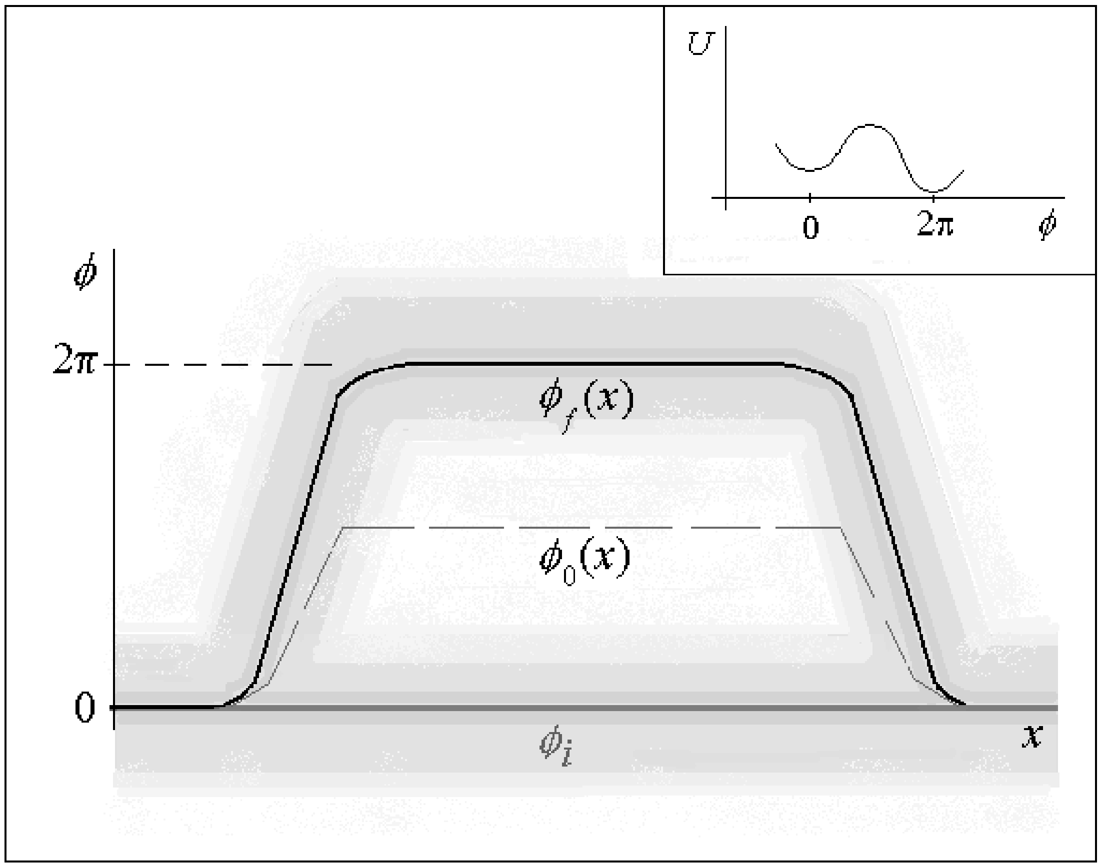
- How does this fit in with t'Hooft's deterministic QM?

- From a 1+ dimensional kink-antikink

$$\Psi_{i,f}\ \left[\phi(\mathbf{x})\right]\Big|_{\phi\equiv\phi_{ci,cf}} = c_{i,f}\cdot\exp\left\{-\int d\mathbf{x}\ \alpha\left[\phi_{C_{i,f}}(\mathbf{x})-\phi_0(\mathbf{x})\right]^2\right\},$$

From density wave physics, 1+ dimensions

Kink-antikinks lead to a vacuum wave function. The LHS is a kink; the RHS is an antikink.



The wave functional should have t'Hooft equivalence class structure added, in 4 to 5 dimensions

- T'Hooft used in 2006 an equivalence class argument as an embedding space for simple harmonic oscillators, as given in his Figure 2, on page 8 of his 2006 article.

- "Beneath Quantum Mechanics, there may be a deterministic theory with (local) information loss. This may lead to a sufficiently complex vacuum state." - t'Hooft

- The author submits, that a kink-anti kink formulation of the graviton, when sufficiently refined, may indeed create such a vacuum state, as a generalization of Fig 2.

One to four-five dimensions in instanton, anti-instaton construction

For one dimension, the semiclassical treatment has (CDW) a kink given by Beckwith(2001) as

$$\phi_{+}\left(z,\tau\right) = 4\cdot\arctan\left(\exp\left\{\frac{z+\beta\cdot\tau}{\sqrt{1-\beta^{2}}}\right\}\right)$$

$$\frac{\partial^{2}\phi\left(z,\tau\right)}{\partial\tau^{2}} - \frac{\partial^{2}\phi\left(z,\tau\right)}{\partial z^{2}} + \sin\phi\left(z,\tau\right) = 0$$

In five dimensions, M. Giovannini (2006) has constructed

For a five dimensional line element,

$$dS^2 = a(w) \cdot \left[\eta_{uv} dx^u dx^v - dw^2 \right]$$

$$\phi = \tilde{v} + \arctan\left((bw)^v \right)$$

Supposition to get about the singularity in 4 dimensions, in early universe models

- Dropping in of ‘information’ to form an instanton-anti-instanton pair, and avoiding the cosmological singularity via the 5th dimension?

- This lead to the author presenting in Chongqing, 11/15/2009 the region about the GR singularity is definable via a ring of space-time about the origin, but not overlapping it, with a time dimension defined

$$\Delta t \equiv 10^{\beta} \cdot t_{Planck}$$

The small mass of the graviton would be for energy in

$$\Delta E \Delta t \geq \hbar$$

- Having said this, the author is fully aware of the String theory HUP variant

$$\Delta x \geq \frac{\hbar}{\Delta p} + \frac{l_s^2}{\hbar} \Delta p$$

- The idea would be to possibly obtain a way to look at counting for GW detectors

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

The following is claimed:

If n (graviton) is obtained, then higher dimensional geometry may be relevant to transmitting information via gravitons from prior to present universes

- How much information can be carried by an individual graviton?
- Assume $\Delta S \approx \Delta N_{gravitons}$
- Use Seth Lloyd's

$$I = S_{total} / k_B \ln 2 = [\# operations]^{3/4} = [\rho \cdot c^5 \cdot t^4 / \hbar]^{3/4}$$

10^{20} relic gravitons yields almost 10^{27} operations!

This value implies that per graviton, as nucleated at least 4 dimensions, there is at least **one unit** of information associated with the graviton (assuming there is at least **some relationship** between an operation and information)

$$\Delta S \approx \Delta N_{gravitons} \approx 10^{20} \Leftrightarrow 10^{20}$$ or higher amounts of prior universe information transmitted to our cosmos?

Cosmological parameters and information from prior to present cosmos ?

- The fine structure constant would probably be a place to start, in terms of information

$$\tilde{\alpha} \equiv e^2 / \hbar \cdot c \equiv \frac{e^2}{d} \times \frac{\lambda}{hc}$$

What the author thinks, is that higher dimensional models of gravity need to be developed, investigated, which may allow for such a counting algorithm.

Resolutions of questions about cosmological constants ?

- **<u>1st Conclusion</u>, one needs a reliable information packing algorithm! I.e. for a wave length , as input into the fine structure constant, we need spatial / information limits defined for geometry**
- $\Delta S \approx \Delta N_{gravitons} \approx 10^{20}$ **is only a beginning**

<u>2nd Conclusion</u>, assumed GW detector sensitivity limits need a comprehensive look over, re do

Important consideration for review - Is there a linkage between neutrinos and gravitons? What about gravitons and E & M (photons)?

- From a 3 page article submitted to the 12th Marcel Grossman conference proceedings
- **STRETCHED NEUTRINOS, AND THE SUPPOSED LINK TO Gravity / Gravitational waves data SETS**
- ANDREW WALCOTT BECKWITH

- The issue of whether or not a correlation exists between neutrino physics and gravitational wave data sets/gravitons is raised anew. Particular emphasis is placed on analysis of the Fuller and Kishimoto scenario, suggesting that the wave function of a relic neutrino may span up to billions of light years across galaxies because of its low energy and particles traveling at different speeds.
- **QUESTION ASKED :**
- If there is an initial close relationship between gravitational waves /gravitons and relic neutrinos in early-universe nucleation, is there a corresponding "stretch-out" of gravitons? If so, what would this imply for improved graviton/gravity wave detectors?

IF so, then what can we say about the following energy density ?

- We first start off with

$$\Omega_{gw} \equiv \frac{\rho_{gw}}{\rho_c} \equiv \int_{f=0}^{f=\infty} d(\log f) \cdot \Omega_{gw}(f)$$

$$\Rightarrow h_0^2 \Omega_{gw}(f) \cong 3.6 \cdot \left[\frac{n_f}{10^{37}}\right] \cdot \left(\frac{f}{1kHz}\right)^4$$

If neutrino-graviton coupling is possible, what also about photons coupled with gravitons? etc ?

- How reasonable then are the following ?

$$n_f \propto n_f[graviton] + n_f[neutrinos]$$

$$n_f \propto n_f[graviton] + n_f[neutrinos] + n_f[photons - E\,\&\,M]$$

Final inquiry, making sense of the supposed "radius of the Universe" calculation

- Matt Roos, has put in a foundational way of testing, via experiment, how to calculate a supposed 'radius of the universe'

$$r_U \equiv \frac{1}{H \cdot \sqrt{|\Omega - 1|}}$$

Tweaking parameters of H, and $\Omega \equiv \rho(t)/\rho_{critical}$ from our inquiry

- The choice of *H*, and of density , as in the
- equation below will allow the dynamics of
- how the universe expands mesh with a fuller
- understanding of structure formation.

$$\Omega \equiv \rho(t)/\rho_{critical}$$

Acknowledgements

- The author thanks **Dr. Raymond Weiss**, of MIT for is interaction in explaining Advanced LIGO technology for the detection of GW for frequencies beyond 1000 Hertz and technology issues with the author in ADM 50, November 7th 2009

- **Dr. Fangyu Li** of Chongqing University is thanked for lending his personal notes to give substance to the content of page 10 of the companion document that complements this PPT, plus his week-long hospitality to the author in China

- **Dr. Christian Corda** is thanked for encouraging the author to explore semiclassical issues in GW and in GR, which lead to a meeting on foundational issues of gravitation in a symposium in Crete, September 2009; and forwarded the Alves et al. document to the author to expand the author's scientific horizons .

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- A.W. Beckwith," **Applications of Euclidian Snyder Geometry to the Foundations of Space Time Physics" http://vixra.org/abs/0912.0012**
- **(Please look at most recent version ! –**
- **for eventual PRD evaluation once cleaned up)**

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Finally a good book summary with up to date summaries

- From “ Series in High Energy physics, Cosmology and Gravitation” - Taylor and Francis (publishers)
- - Particle and Astroparticle Physics (2008)
- By Utpal Sarkar