Journal of Theoretics

Volume 6-2, April/May 2004

The Source of the Cosmological Constant

Paul Hoiland paultrr2000@yahoo.com

Abstract: Following the Randall-Sundram model I shall show the source of both the Cosmological Constant and why we observe both an accelerated expansion and a time/scale varying value for C.
Keywords: cosmological constant, general relativity.

The Description of gravity on the brane, following the Randall-Sundram model [1] utilizes a modified 4D Einstein equation first derived by Shiromizu, Maeda, and Sasaki [2], from the 5D gravity via utilizing Gauss and Codazzi equations. In a vacuum state with no matter present the Cosmological constant equals zero and this equation reduces to:

$$G_{uv}=-E_{uv} \ .$$

E_{uv} is the 5D projection then of the Weyl tensor off the brane. This before, required state is also forfilled by certain small scales within normal space-time so that the equation for gravity can hold for them also. The traceless tensor E_{uv} connects gravity on the brane with the bulk extra brane state. This set of equations is not closed and it can admit to energy condition violations involving exotic energy states and possible expanded lightcone states.

The *tensor* C_{abcd} is defined by

$$R_{abcd} = C_{abcd} + \frac{2}{n-2}(g_{a[c}R_{d]b} - g_{b[c}R_{d]a}) - \frac{2}{(n-1)(n-2)} R g_{a[c}g_{d]b},$$

where R_{abcd} is the *Riemann tensor*, *R* is the *scalar curvature*, g_{ab} is the *metric tensor*, and $T_{[a_1 \ldots a_n]}$ denotes the *anti-symmetric tensor* part where using this Weyl tensor every *tensor contraction* between indices gives 0. In particular,

$$C^{\lambda}{}_{\mu\lambda\kappa} = 0 \ ,$$

one can derive the number of independent components for a Weyl tensor in *N*-D for N$\geq$ 3 is given by

$$C_N = \frac{1}{12} N(N+1)(N+2)(N-3)$$

For *N* = 3, 4, ..., this gives 0, 10, 35, 84, 168 as an example. This generalization gives the following result for N>3

$$R_{\alpha\beta\gamma\delta} = C_{\alpha\beta\gamma\delta} - \frac{\left(g_{\alpha\delta}R_{\gamma\beta} + g_{\beta\gamma}R_{\delta\alpha} - g_{\alpha\gamma}R_{\delta\beta} - g_{\beta\delta}R_{\gamma\alpha}\right)}{n-2} - \frac{\left(g_{\alpha\gamma}g_{\delta\beta} - g_{\alpha\delta}g_{\gamma\beta}\right)R}{(n-1)(n-2)}.$$

In *n*-dimensions, where N>3 the Wyle Tensor can be written:

$$\begin{aligned} C_{\alpha\beta\gamma\delta} &\equiv R_{\alpha\beta\gamma\delta} \\ &+ \frac{\left(g_{\alpha\delta}R_{\gamma\beta} + g_{\beta\gamma}R_{\delta\alpha} - g_{\alpha\gamma}R_{\delta\beta} - g_{\beta\delta}R_{\gamma\alpha}\right)}{n-2} \\ &+ \frac{\left(g_{\alpha\gamma}g_{\delta\beta} - g_{\alpha\delta}g_{\gamma\beta}\right)R}{(n-1)(n-2)} \end{aligned}$$

$$\begin{aligned} C_{\alpha\beta\gamma\delta} &\equiv R_{\alpha\beta\gamma\delta} \\ &+ \tfrac{1}{2}\left(g_{\alpha\delta}R_{\gamma\beta} + g_{\beta\gamma}R_{\delta\alpha} - g_{\alpha\gamma}R_{\delta\beta} - g_{\beta\delta}R_{\gamma\alpha}\right) \\ &+ \tfrac{1}{6}\left(g_{\alpha\gamma}g_{\delta\beta} - g_{\alpha\delta}g_{\gamma\beta}\right)R \end{aligned}.$$

The important thing to remember is the Weyl tensor possesses the same symmetries as the Riemann tensor. So the symmetries involved in *on* the brane states should be conserved in *off* the brane states. However, the negative energy conditions possible for *off* the brane and certain involved expanded lightcone states, make it possible that faster than light conditions of communication are possible, even if the Lorentz Symmetry is still enforced.

The Weyl tensor in General Relativity provides curvature to space-time when the Ricci tensor is zero. In General Relativity the source of the Ricci tensor is the energy-momentum of the local matter distribution. If the matter distribution is zero then the Ricci tensor will be zero. However space-time is not necessarily flat in this case since the Weyl tensor contributes curvature to the Riemann curvature tensor and so the gravitational field is not zero in space-time void situations. This term allows gravity to propagate in regions where there is not any matter/energy source. The important thing here is that the value of E_{uv} is negative for off the brane states. To the degree it is negative, the more *off* the brane state approximates an inflation field's dynamics. So the off the brane curvature effect is such that its natural state would be an expanding or hyper expanded space-time.

However, going back to the common model, this 5D region is compacted. So, its forced energy condition is not it's normal one. It attempts to re-inflate causing a reaction inside of the brane condition via an energy transfer along the connection we term the cosmological constant. This energy is 180 degrees phase reversed by the transfer process such that it becomes more positive as the universe expands, while the *off* the brane condition is becoming more negative with time. The result is an accelerated expansion that is time dependent and a variable speed of light for the brane state. What controls the speed of light and the expansion is the effect its energy has on the global value of the Stress Energy Tensor, T_{uv}. It is this phase reversal of the flow of energy that points to the extra time condition of the off the brane state that lead me in my own M-Theory model (3) to adopt a dual time approach. So in reality both the *on* the brane state and the *off* the brane state are mirror copies of each other. This implies a dual universe being in existence. As time flows forward in our perspective, time flows backwards in the twin's perspective, so to speak. The reason then that *off* the brane state displays a natural faster than light condition is that they exhibit tachyionic like conditions.

References:

1.) L. Randall, R. Sundram. Phys. Rev. Lett.. 83 4690 (1999).

2.) T. Shiromizu, K. Maeda, M. Sasaki, Phys. Rev. D. 62, 024012 (2000).

3.) P. Hoiland, A Modification to M-Theory, http://www.superstringtheory.fanspace.com/ .

Received December 2002

Journal Home Page