Radiating Braneworlds

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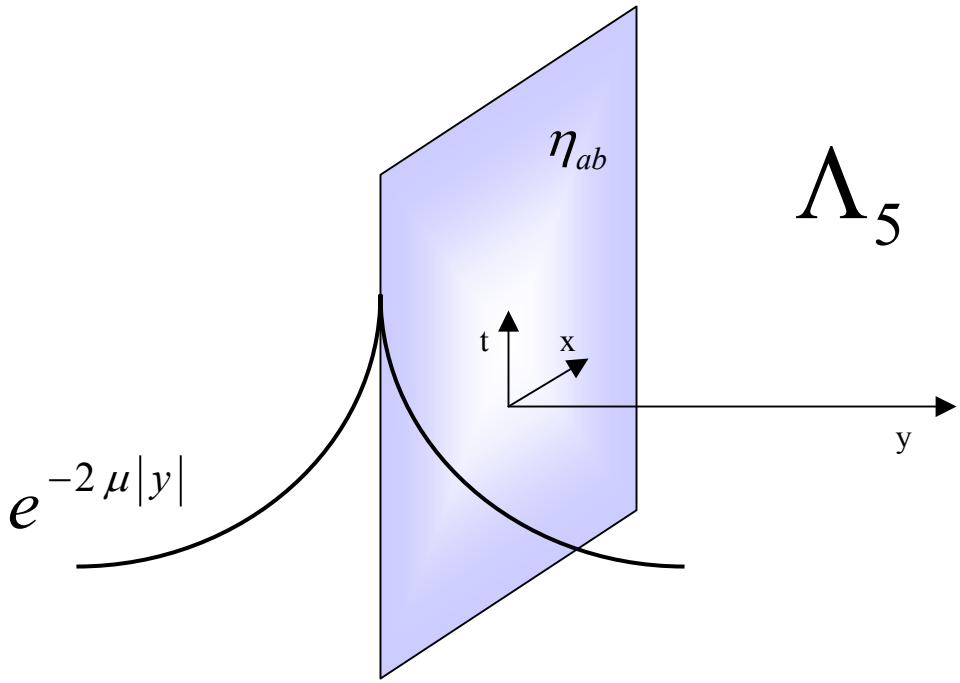
Based on work by E Leeper, R. Maartens & C. Sopuerta
[gr-qc/0309080]
and on work by E. Leeper, R. Maartens & L. Gergely
[gr-qc/0408084]

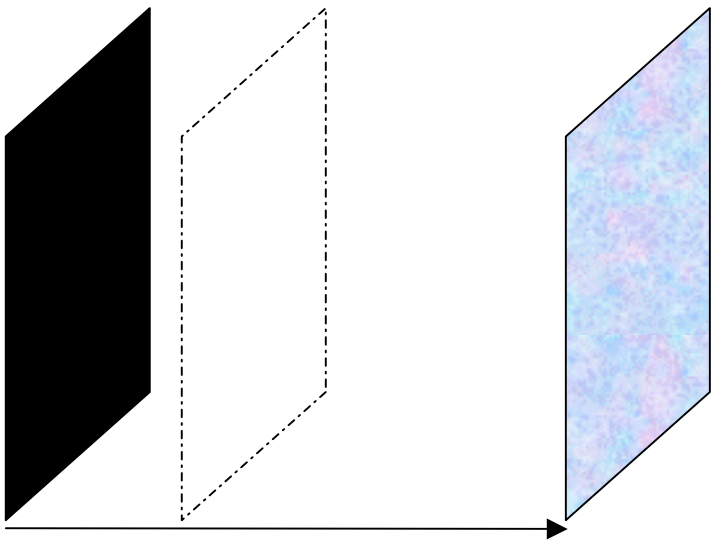
Randall Sundrum II



Bulk metric $$ds^2 = dy^2 + e^{-2\mu|y|}\eta_{ab}dx^a dx^b$$

Schwarzschild - Anti de Sitter

Bulk metric $ds^2 = -f dT^2 + \frac{1}{f} dR^2 + R^2 d\Omega_{3,k}^2$ $\qquad f = k + \mu^2 R^2 + \frac{C}{R^2}$



$R = a(t)$

Brane metric

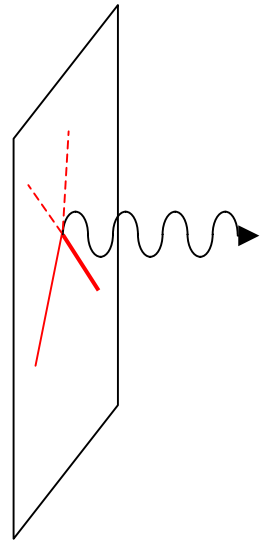
$${}^{(4)}ds^2 = dt^2 + a(t)^2 d\Omega_{3,k}^2$$

Friedmann equation

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{\kappa_4^2}{3}\rho + \frac{\kappa_4^2}{6\lambda}\rho^2 + \frac{C}{a^4} + \left(\frac{\kappa_4^2}{6}\lambda + \Lambda_5\right)$$

Vaidya metric

$$ds^2 = -f(v,R)dv^2 + 2dvdR + R^2 d\underline{x}^2$$



Satisfies the Einstein equations

$${}^{(5)}G_{AB} = \kappa_5^2 T_{AB} - \Lambda_5 g_{AB}$$

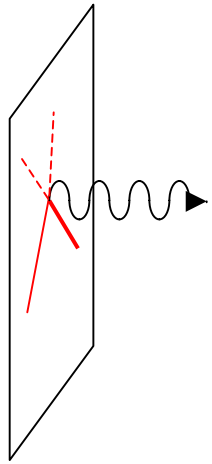
with $T_{AB} = \sigma k_A k_B$

$$\frac{dC}{dt} = \frac{2\kappa^2\sigma}{3} a^4 \rho^2 (\lambda + \rho - H)$$

Dynamic equations

$$H^2 = \frac{\kappa_4^2}{3}\rho + \frac{\kappa_4^2}{6\lambda}\rho^2 + \frac{C}{a^4}$$

$$\frac{d\rho}{dt} + 3H(\rho + p) = -2\sigma$$



In the radiation era on the brane:

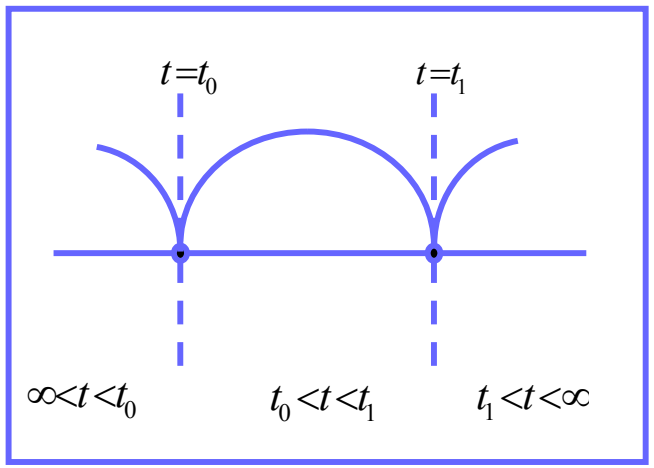
$$p = \frac{1}{3}\rho \quad , \quad \sigma = \frac{\kappa_5^2}{12}\alpha\rho^2$$

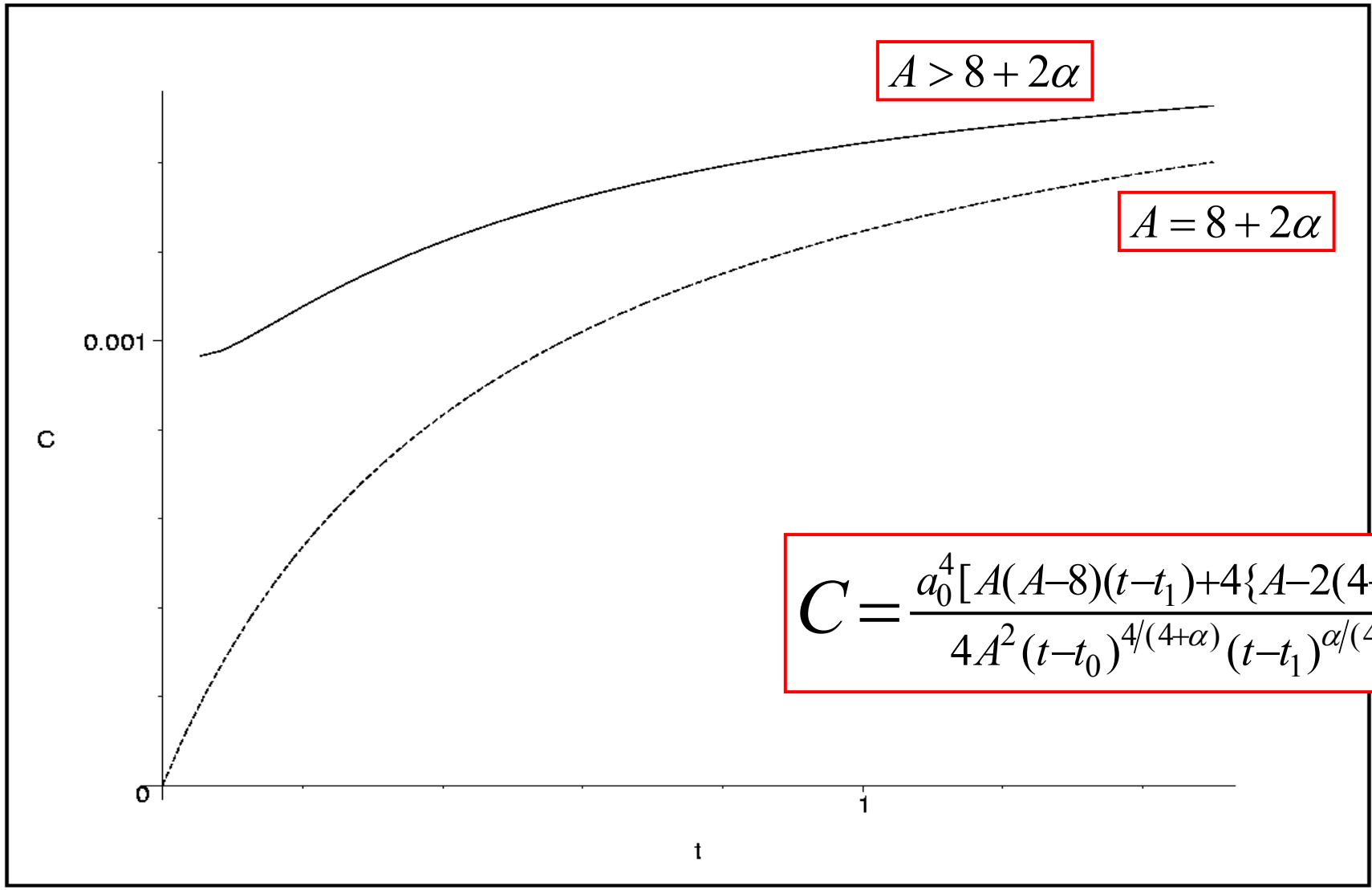
The dynamic equations have an exact solution!

$$\rho = \frac{1}{A(t-t_0)(t-t_1)}$$

$$a = a_0 (t-t_0)^{(2+\alpha)/2(4+\alpha)} (t-t_1)^{1/(4+\alpha)}$$

$$C = \frac{a_0^4 [A(A-8)(t-t_1)+4\{A-2(4+\alpha)\}]}{4A^2 (t-t_0)^{4/(4+\alpha)} (t-t_1)^{\alpha/(4+\alpha)}}$$





$$C = \frac{a_0^4[A(A-8)(t-t_1)+4\{A-2(4+\alpha)\}]}{4A^2(t-t_0)^{4/(4+\alpha)}(t-t_1)^{\alpha/(4+\alpha)}}$$

Relax $\mathbf{Z}_2$ Symmetry Assumption

$$H^2 = 2\rho + \rho^2 + \frac{C}{a^4} + \frac{(q + 3\xi a^4)^2}{4a^8(\rho + 1)^2}$$

Extra term

$$\frac{dC}{dt} = 2\alpha a^4 \rho^2 (\lambda + \rho - H)$$

Same C equation

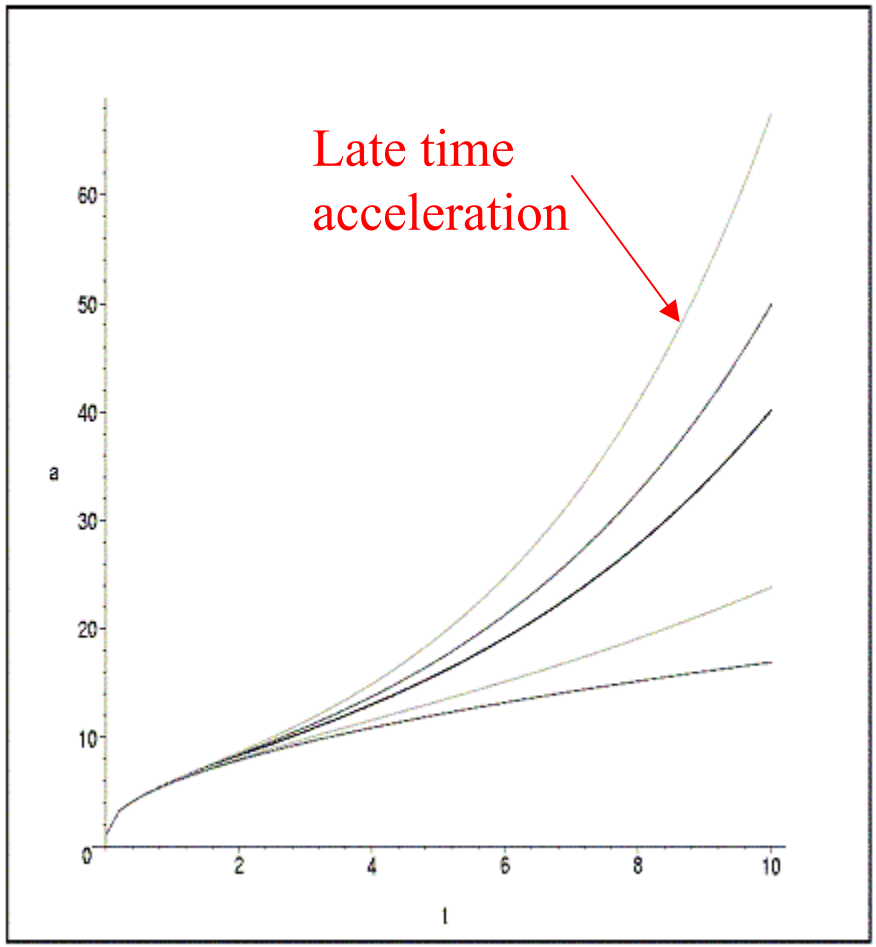
$$\frac{d\rho}{dt} + 4H\rho = -\alpha\rho^2$$

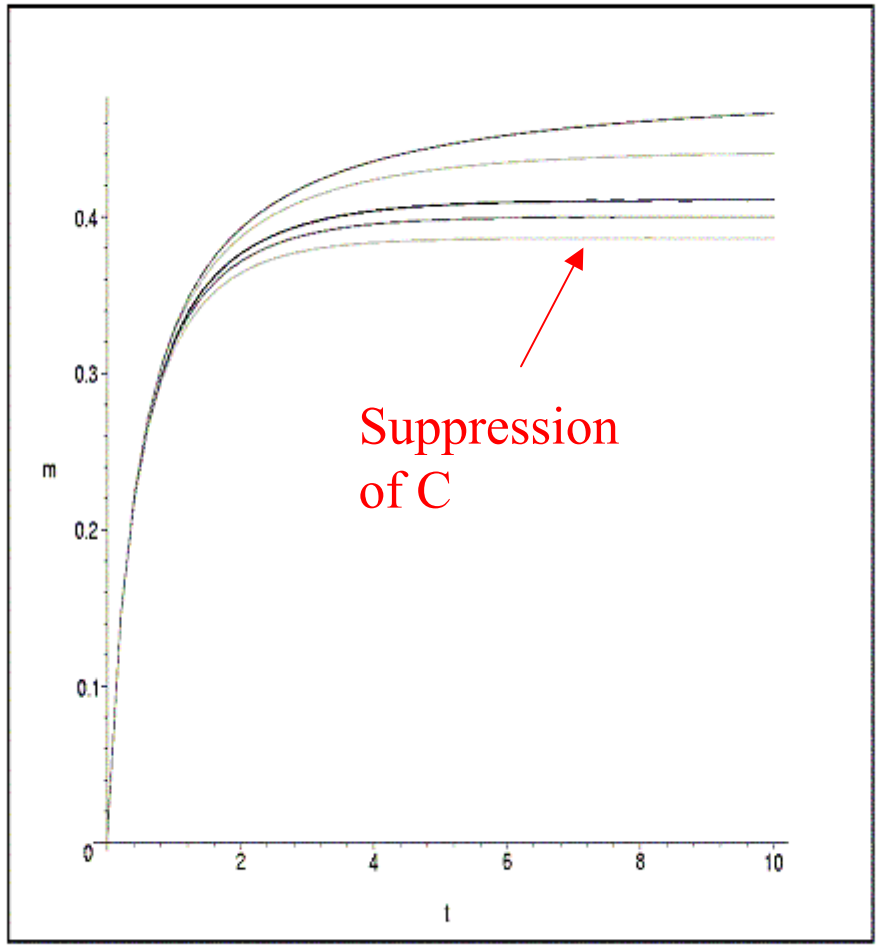
Same non-conservation equation

$$\frac{dq}{dt} = -\frac{\alpha\rho^2 (q + 3\xi a^4)}{(\rho + 1)}$$

evolution equation for Δm

Effect of Asymmetry





Summary

- We expect gravitational radiation from high energy braneworlds into the bulk
- This gravitational radiation will give the bulk a black hole metric
- The effect on the brane is of a variable amount of dark radiation
- A family of analytic solutions are presented
- This is a simplified model – more detailed work could be done (following Langlois & Sorbo [hep-th/0306281])
- Relaxing the symmetry assumption can give late-time acceleration and suppress the final amount of dark radiation