Photon Mixing in Domain Walls and Cosmic Coincidences

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The Coincidence Problem

- Observations of Type 1a supernovae suggest Ω_Λ=0.7, Ω_M=0.3
- That means $\rho_\Lambda=\rho_M$ at z=0.3
- Does this need to be explained?
- Quintessence models exist, but require fields with masses $m_Q=10^{-33}$eV=(Hubble radius)$^{-1}$

Anthropic Arguments:

If ρ_Λ was even slightly larger, galaxies could not form (Martel, Shapiro & Weinberg astro-ph/9701099) and life could not exist

So is it time to give up the scientific method?

Or can we think of an alternative?

Photon-Axion Mixing

Csaki, Kaloper & Terning hep-ph/0111311

ultra light axion, photons from supernovae convert into axions in the intergalactic magnetic field, gives the illusion of $\Lambda>0$

$$L = -\frac{1}{2}\left(\partial^{\mu} a \partial_{\mu} a + m^2 a^2\right) + \frac{a}{M} F_{\mu\upsilon}\tilde{F}^{\mu\nu} - \frac{1}{4} F_{\mu\nu} F^{\mu\nu}$$

probability of a photon remaining a photon:-

$$P_{\gamma\to\gamma} = 1 - \frac{B^2\omega^2}{m^4 M^2 + B^2\omega^2} \sin^2\left[\frac{\sqrt{m^4 M^2 + B^2\omega^2}}{\omega M} L\right]$$

to get right dimming, we require M/B=Hubble Length

to suppress oscillations of CMB photons:-

$$\omega_{optical} > \frac{m^2 M}{B} > \omega_{cmb}$$

intergalactic electrons cause problems

Mixing with Paraphotons

$$L = -\frac{1}{4g^2} F^{\mu\nu} F_{\mu\nu} - \frac{1}{4g'^2} G^{\mu\nu} G_{\mu\nu} - \frac{\chi}{g' g} F^{\mu\nu} G_{\mu\nu}$$

$$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu \qquad G_{\mu\nu} = \partial_\mu A'_\nu - \partial_\nu A'_\mu$$

Additional U(1) gauge field weakly coupled to electromagnetism ($\chi << 1$) except inside the core of domain walls

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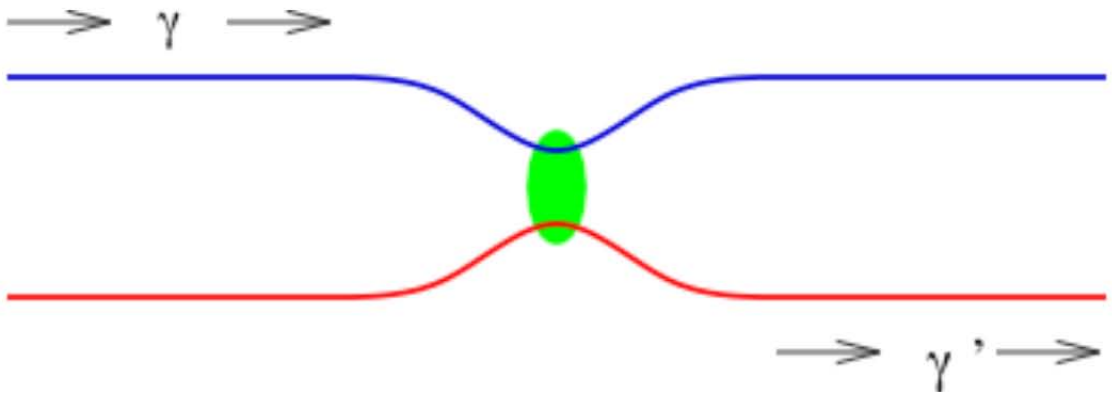
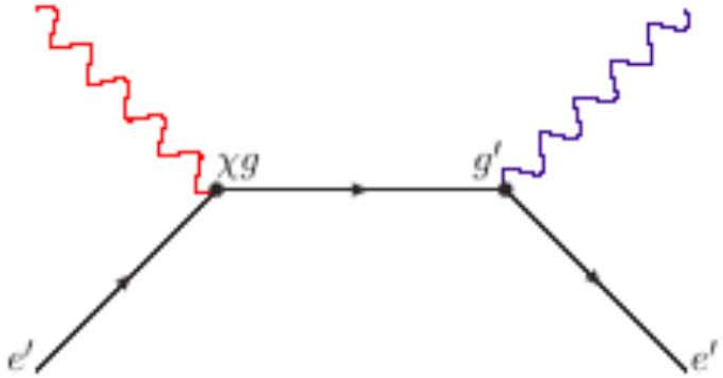
Photon Mixing in Domain Walls

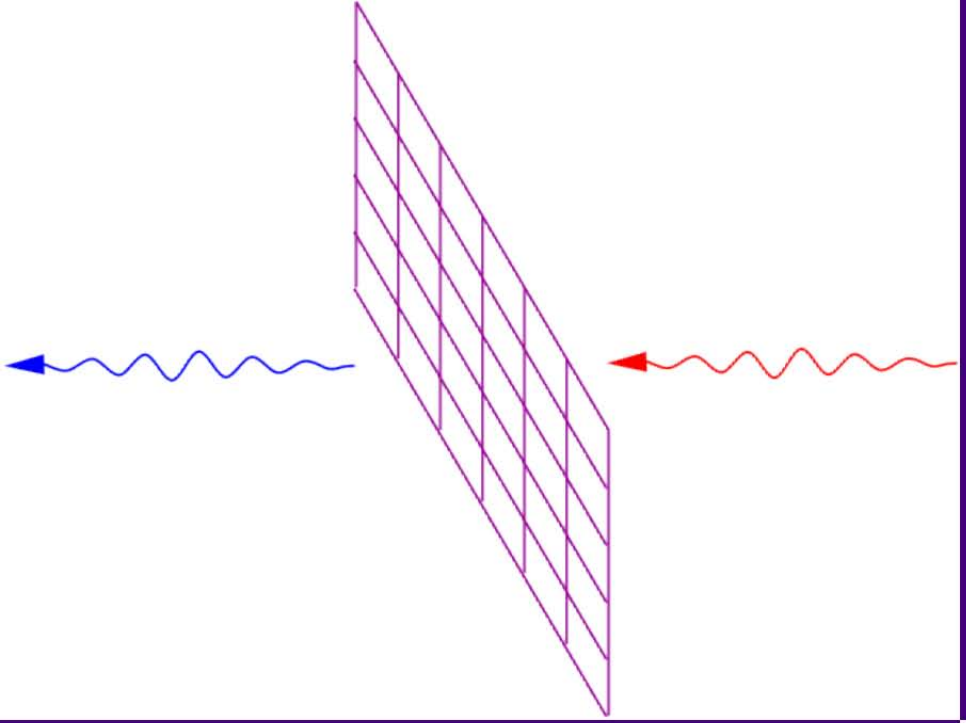
kinks in relative position of branes in compact space



Inside core, branes closer than mass of fields in bulk



Photons and paraphotons massless :-
need population of paraelectrons to introduce refractive index.



Since there is one domain wall per horizon, approximately 50% of photons created at redshift z=1 are lost. This does not depend on any of the energy scales in the model.

$$P_{\gamma\to\gamma} = \frac{1}{2}\left(1 + e^{-N(z)}\right)$$

Where N(z) is the number of domain walls crossed by a photon emitted at redshift z

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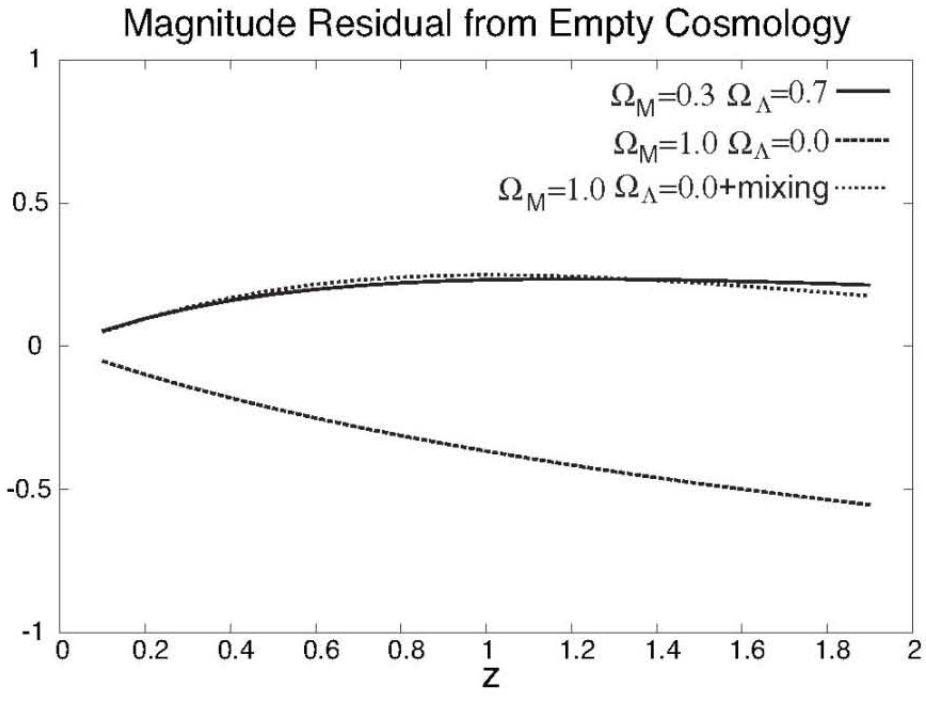
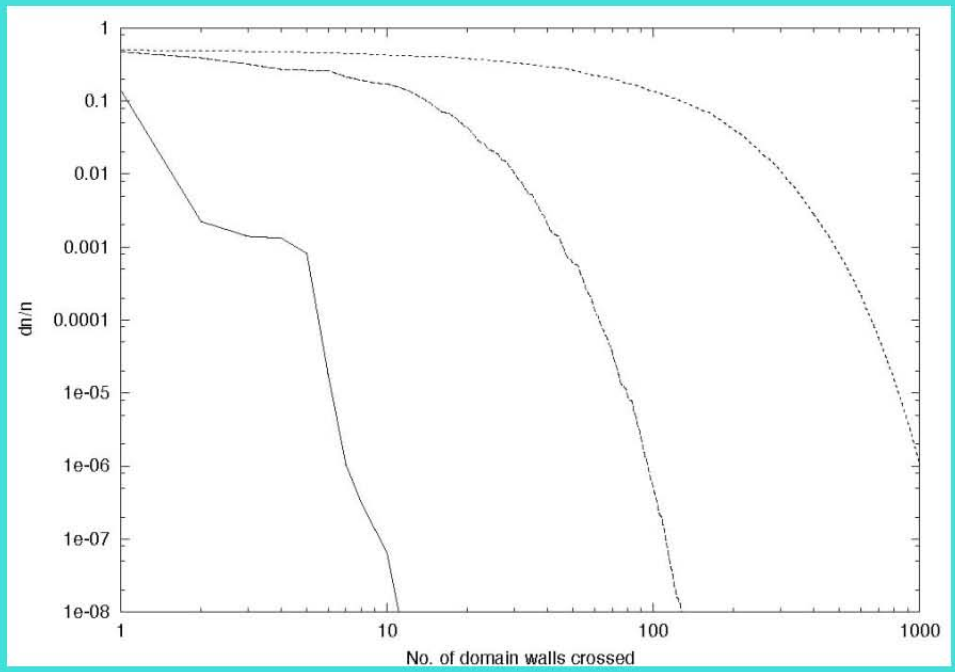


Isn't this dangerous for CMB photons ?

- CMB photons reaching earth today have crossed ~1000 domain walls
- Distortion due to mixing of photons less than 10^{-5} rather quickly ~10 walls for 50% probability of mixing per wall
- Para-electrons need to be cool to avoid SZ effect while photons are on other brane



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Conclusions

- Photon mixing in Domain walls changes luminosity distance
- No mass scale set to inverse Hubble length required
- Observers at any redshift conclude universe has recently started to accelerate

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