A Relook at the No-Boundry Idea

Abstract: In considering the multiverse idea one comes across the subject of the domain wall that seperates our cosmos from that original false vacuum domain. In general that domain and the wall itself effects the evolution of the cosmos. But very few direct signatures would result.

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In multiverse modeling our universe arose as a decaying false vacuum state out of a much larger false vacuum frame. As such the real boundary of our universe would be the domain wall that formed between us and that false vacuum state. But the question arises how does that wall and the external false vacuum state and any other possible universes effect us.

Starting with

$$\left(ds^2\right)^+ = g^+_{\mu\nu} dx^\mu_+ dx^\nu_+ = -\left(1-\frac{2M}{r}\right)dt^2 + \frac{dr^2}{1-\frac{2M}{r}} + r^2\left(d\theta^2 + sin^2\theta\ d\phi^2\right).$$

and assuming

$$\Delta t = \int_{R_s}^{R_0} \frac{dr}{1-\frac{2M}{r}} \to \infty,$$

as the Schwarzschild time interval we discover that while the outer domain wall effects evolution internal within our space-time, external it has no effect on any sort of evolution of the false vacuum frame itself in which it is embedded. Especially when we consider and assume that

$$a\left(\eta\right)_{-},$$

the scale factor for that frame and that as such the time factor for it is zero or even if it evolves such a time factor would be different from our own.

But this changes in a quantum perspective. The horizon radius in respect to the false vacuum domain

$$R = R_s + \delta R_s$$

has an uncertainty expressed as

$$\delta R_s$$

yielding a time interval of

$$\int_{t_f}^{t_i} \frac{d\eta}{a^2(\eta)} = \int_{R_s+\delta R_s}^{R_0} \frac{dr}{1-\frac{R_s}{r}} \sim R_s \ln \frac{R_0 - R_s}{\delta R_s}.$$

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Thus, the near infinite uncertainty implies at a quantum scale some sort of entangled effect not only having effect at that scale on the false vacuum, but also upon other possible existing domains themselves embedded in such a frame.

Following the more simple model of the Nambu-GoTo we get an action expressed as

$$S = \int d^4x\sqrt{-g}\left[-\frac{1}{16\pi}R + \frac{1}{2}\left(\partial_\mu \Phi\right)^2\right] - \sigma \int d^3\zeta \sqrt{-\zeta} + S_{obs},$$

which includes the

$$\zeta^a$$

as denoting the coordinates of the wall itself expressed in (1+2) dimensional format. Following an Israel format for the junction conditions we can graph such as:

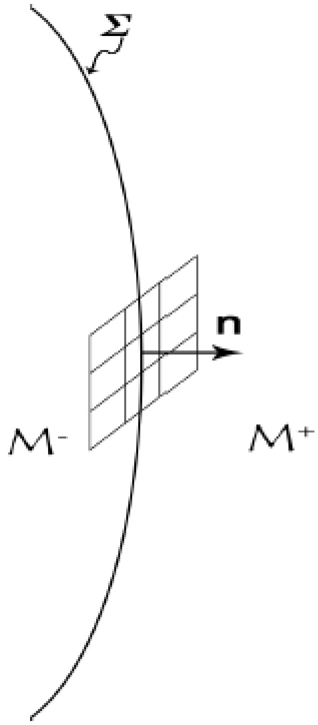

FIG. 1: The timelike hypersurface Σ is shown which forms the boundary of the individual spacetime regions M^- and M^+. The normal $\mathbf{n}$ is also depicted.

In this case we are the M- and the false vacuum state is the M+ region. If we then take

$$R^{\alpha}{}_{\beta\mu\nu} = R^{\lambda}{}_{\gamma\sigma\rho}h^{\alpha}{}_{\lambda}h^{\gamma}{}_{\beta}h^{\rho}{}_{\nu} + \epsilon\left(K^{\alpha}{}_{\mu}K_{\beta\nu} - K^{\alpha}{}_{\nu}K_{\beta\mu}\right),$$

and

$$\nabla_{\alpha}K_{\beta\mu} - {}^{(3)}\nabla_{\mu}K_{\beta\alpha} = R^{\lambda}{}_{\sigma\rho\delta}n_{\lambda}h^{\sigma}{}_{\beta}h^{\rho}{}_{\alpha}h^{\delta}{}_{\mu},$$

we get the relationship of interior to exterior both as

$$E_{\mu\nu}n^{\mu}n^{\nu} = -\frac{1}{2}\epsilon^{(3)}R + \frac{1}{2}\left(K^2 - K_{\alpha\beta}K^{\alpha\beta}\right),$$

$$E_{\mu\nu}h^{\mu}{}_{\alpha}n^{\nu} = -\left({}^{(3)}\nabla_{\mu}K^{\mu}{}_{\alpha} - {}^{(3)}\nabla_{\alpha}K\right).$$

The Einstein field equation becomes

$$E_{\mu\nu}^{\pm} = \kappa T_{\mu\nu}^{\pm},$$

where

$$R_{\mu\nu}$$

is the Ricci curvature tensor,

$$R = g^{\mu\nu} R_{\mu\nu},$$

is the Ricci scalar and

$$T_{\mu\nu}$$

is the stress energy tensor. We now derive that

$$E_{\mu\nu} = R_{\mu\nu} - \frac{1}{2} R g_{\mu\nu}$$

showing that there exists an evolution entanglement itself with the domain wall and both frames. Our region interior of this wall takes the metric form

$$\left(ds^2\right)^- = g_{\mu\nu}^- = -dT^2 + a^2(\eta)\left[dr^2 + r^2\left(d\theta^2 + \sin^2\theta d\phi^2\right)\right],$$

If mass vanishes at the wall the

$$a(\eta)$$

becomes suppressed. If not then it comes into play. If we then (1+1) slice of the interior

$$\alpha = \frac{dT}{d\tau} = \sqrt{1 + a^2 R_\tau^2},$$

with the exterior

$$\beta = \frac{d\eta}{d\tau} = \frac{1}{1-\frac{2M}{R}}\sqrt{1-\frac{2M}{R}+a^2R_\tau^2},$$

We get a time relationship of

$$\dot{T} = \frac{dT}{d\eta} = \sqrt{1-\frac{2M}{R}-\frac{\frac{2M}{R}a^2\dot{R}^2}{1-\frac{2M}{R}}},$$

which shows a relationship with

η.

Since the domain wall is located at

$u \to -\infty$

with respect to us the question arises what effect would its shift outward or inward have on our present observation of the cosmos. Only if that horizon where to cross our current position along

$u \to -\infty$

would we ever see it's effect. And given the long finite time for any signal to reach us any outward expansion would itself take an equally long time to arrive at our position. Now if we already crossed such a boundary where those signals have reached us we might detect in the last case an accelerated expansion of the cosmos. And in the first case we would not be here to even reflect upon that question if the boundary is already here and if only its signal has arrived all we would detect is a recollapse of the cosmos.

Reference

Math treatment comes from recent work by

Jackson Levi Said and Kristian Zarb Adami In

Cosmological Effects on Black Hole Formation