8. Humphreys, Ref. 1, p. 196, Section 2, sixth paragraph.

Vistas — one more

As in his original cosmology proposal[1,2] and in subsequent writings in its defence,[3,4] so also in New vistas of space-time rebut the critics,[5] Dr Humphreys makes sweeping physical claims without backing them up with the simple mathematical calculations which would demonstrate their truth or falsity.

It is straightforward, using only undergraduate-level differential calculus, to show that Humphreys' claim of a 'timeless zone' in the Klein metric is false. In order for a 'timeless zone' to exist, there must be a region of spacetime within which there are no spacetime trajectories which have the property $ds^2 > 0$. However, it is easy to verify that every comoving clock in Humphreys' bounded matter sphere cosmology traverses a timelike trajectory ($ds^2 > 0$), even in the region of (α,χ) space which Humphreys alleges is 'timeless.' Consider, for example, the trajectory of the Earth, which Humphreys hypothesizes is at the center of the matter sphere. The Earth's spatial trajectory in Schwarzschild coordinates is given by $d\rho_{Earth} = d\theta_{Earth} = d\varphi_{Earth} = 0$. The Schwarzschild time component of the trajectory, $dt_{Schwarz,\ Earth}$, must be derived from the definition of the Schwarzschild time coordinate $t_{Schwarz}$,

See equation (1) [below]

Humphreys claims that $dt_{Schwarz}$ is a 'conceptual' time interval which can be assumed to be real, so that $dt^2_{Schwarz}$ is positive[6], but this is manifestly false. The value of $t_{Schwarz}$ for a particular spacetime event is manifestly a function (given in equation 1) of the comoving coordinate location (a,η) of the spacetime event in question, and therefore the Schwarzschild time interval $dt_{Schwarz}$ along a particular spacetime trajectory is determined by that trajectory (i.e., by the succession of spacetime events which constitutes the trajectory).

To obtain the differential Schwarzschild time interval $dt_{Schwarz,\ comoving\ clock}$ which elapses along the spacetime trajectory of a comoving clock, one must differentiate equation (1), subject to the constraint imposed by the spacetime trajectory under consideration (namely that η is fixed for a comoving clock). The result is

See equation (2)

(where the leading '-' sign in equation (1) is used, as is appropriate for an expanding bounded matter sphere)[7]. Earth is located at $\eta_{Earth} = 0$, so

See equation (3)

$$t_{Schwarz} = \pm\frac{t_o}{1+b^2}\left[\frac{b^3}{1+b^2}\ln\left(\frac{\zeta+b}{\zeta-b}\right)+\frac{\zeta}{1+\zeta^2}+\frac{1+3b^2}{1+b^2}\left(\frac{\pi}{2}-\arctan\zeta\right)\right] \qquad (1)$$

where

$$t_0 \equiv \frac{a_{max}}{c\sqrt{1-\eta^2_{edge}}},\quad \zeta \equiv \sqrt{\frac{a_{max}}{a_{max}-a}\sqrt{\frac{1-\eta^2_{edge}}{1-\eta^2}}-1},\quad b \equiv \frac{\eta_{edge}}{\sqrt{\eta^2_{edge}}}$$

$$dt_{schwarz,comoving\ clock} = da\frac{\partial t(a,\eta)}{\partial a}\bigg|_{\eta\ fixed} = -t_o\frac{\zeta^3}{\left(1+\zeta^2\right)^2\left(\zeta^2-b^2\right)}\left(\frac{1+\eta^2_{edge}}{1-\eta^2}\right)^{1/2}\frac{a_{max}}{\left(a_{max}-a\right)^2}da \qquad (2)$$

$$dt_{Schwarz,\ Earth} = -t_0\frac{\zeta^3_{Earth}}{\left(1+\zeta^2_{Earth}\right)^2\left(\zeta^2_{Earth}-b^2\right)}\left(1-\eta^2_{edge}\right)^{1/2}\frac{a_{max}}{\left(a_{max}-a\right)^2}da \qquad (3)$$

$$\zeta_{Earth} = \zeta\left(a,\eta_{Earth}\right) = \sqrt{\frac{a_{max}}{a_{max}-a}\sqrt{1-\eta^2_{edge}}-1} \qquad (4)$$

where

See equation (4)

Plugging the values of Earth's coordinate trajectory differentials into the metric gives,

$ds^2_{Earth} = c^2 d\tau^2_{Earth}$

$= \beta(a,\eta=0)c^2 dt^2_{Schwarz,\ Earth}$

See equation (5)

To determine whether there is a timeless region along Earth's space-time trajectory, we need only locate those regions for which ds^2_{Earth} is negative.

It is easy to see that ζ_{Earth} is real when $a/a_{max} > 1 - (1 - \eta^2_{edge})^{1/2}$ and imaginary (that is, proportional to $(-1)^{1/2}$), when $a/a_{max} < 1 - (1 - \eta^2_{edge})^{1/2}$. Therefore, $dt_{Schwarz,\ Earth}$ is real and $dt^2_{Schwarz,\ Earth}$ is positive for $a/a_{max} > 1 - (1 - \eta^2_{edge})^{1/2}$. Likewise, $dt_{Schwarz,\ Earth}$ is imaginary and $dt^2_{Schwarz,\ Earth}$ is negative for $a/a_{max} < 1 - (1 - \eta^2_{edge})^{1/2}$. ζ_{Earth} and $dt_{Schwarz,\ Earth}$ vanish at $a/a_{max} = 1 - (1 - \eta^2_{edge})^{1/2}$.

The metric component b(a,h), which we need to compute the Earth proper time using equation 5, is given by

See equation (6)

At the position of Earth, $\beta(a,\eta=0)$ is

See equation (7)

Or, equivalently,

See equation (8)

The numerator of $\beta(a,\eta=0)$ is the square of a real number, and so is necessarily non-negative. The sign of the denominator and thus of $\beta(a,\eta=0)$ depends on the value of a/a_{max}. Considering the same three cases as above, a/a_{max} greater than, less than or equal to $1 - (1 - \eta^2_{edge})^{1/2}$, it is obvious that

I) if $a/a_{max} > 1 - (1 - h^2_{edge})^{1/2}$, then b (a,h=0) > 0 and $dt^2_{Schwarz,\ Earth} > 0$, so that $ds^2_{Earth} > 0$, a timelike trajectory.

II) if $a/a_{max} < 1 - (1 - h^2_{edge})^{1/2}$, then b(a,h=0) < 0 and $dt^2_{Schwarz,\ Earth} < 0$, so that $ds^2_{Earth} > 0$, a timelike trajectory.

It should be noted that case II), with b < 0, is precisely Humphreys' so-called 'timeless' region of the Klein metric. Earth clocks are not stopped in the region, however, since $ds^2_{Earth} > 0$. The reason for this is that whenever b is negative, $dt_{Schwarz,\ Earth}$ is imaginary, so that $dt^2_{Schwarz,\ Earth}$ is also negative, yielding $ds^2_{Earth} > 0$.

III) if $a/a_{max} = 1 - (1 - h^2_{edge})^{1/2}$, then b(a,h=0) diverges and $dt^2_{Schwarz,\ Earth} = 0$. It is not obvious from this analysis what is the value of the product b(a,h) $dt^2_{Schwarz,\ Earth}$, but in our recent CEN Tech. J. article[8] and the Supplement to it[9] we show that even in this case, $ds^2_{Earth} > 0$, a timelike trajectory.

This simple analysis for the spacetime trajectory of Earth through the Euclidean signature region of the Klein metric can be easily repeated for any other comoving trajectory (that is, any non-zero value of η). The outcome is the same: $\beta(a,\eta)$ and $dt^2_{Schwarz,\ comoving\ clock}$ always have the same sign, so that their product is always positive. One additionally must take into account the radial motion $dr_{comoving\ clock}$, but the additional contribution still leaves $ds^2_{comoving\ clock}$ positive, as we show in the Supplement. Further, whenever $\beta(a,\eta)$ diverges, $dt^2_{Schwarz,\ comoving\ clock}$ vanishes and whenever $\beta(a,\eta)$ vanishes, $dt^2_{Schwarz,\ comoving\ clock}$ diverges in such a way that the product $\beta\, dt^2$ remains finite and positive[10]. As Dr Page and I discuss in our paper and Supplement, explicit derivation of the proper time interval using the Klein metric shows that the proper time interval along every comoving clock trajectory in the interior of the

$$ds^2_{Earth} = c^2 d\tau^2_{Earth} = \beta(a,\eta=0)c^2 dt^2_{Schwarz,\ Earth} \quad \text{......................(5)}$$

$$\beta_{(a,\eta)} = \frac{\left[1 - \frac{a_{max}}{a}\left(1 - \frac{\left(1-\eta^2_{edge}\right)^{3/2}}{\sqrt{1-\eta^2}}\right)\right]^2}{\left(1 - \frac{a_{max}}{a}\eta^2\right)\left[1 - \frac{a_{max}}{a}\left(1 - \frac{\sqrt{1-\eta^2_{edge}}}{\sqrt{1-\eta^2}}\right)\right]^3} \quad \text{..........(6)}$$

$$\beta(a,\eta=0) = \frac{\left[1 - \frac{a_{max}}{a}\left(1 - \left(1-\eta^2_{edge}\right)^{3/2}\right)\right]^2}{\left[1 - \frac{a_{max}}{a}\left(1 - \sqrt{1-\eta^2_{edge}}\right)\right]^3} \quad \text{......................(7)}$$

matter sphere is

See equation (9)

In other words, there are no timeless regions in the Klein metric. Humphreys comes close to noticing this ‘compensating’ behavior of $t_{Schwarz}$ ($dt_{Schwarz,\ comoving\ clock}$ is imaginary when β is negative) when he writes:

> ‘I now know that the location in question [i.e. at which the Schwarzschild time coordinate acquires an imaginary component] is not the event horizon, but rather the change surface, and that the imaginary component [of the Schwarzschild time coordinate] comes from a signature change in the Klein metric.’[11]

This behaviour, wherein the time coordinate suddenly acquires an imaginary component as one crosses the signature change surface, is a clear indication that the signature change is an artefact of the coordinate system. Humphreys seems to recognize that this is the case. However, he fails to recognize that such a coordinate artifact cannot convert the timelike trajectories of comoving clocks ($ds^2_{comoving\ clock} > 0$) into spacelike trajectories ($ds^2_{comoving\ clock} < 0$). Such a conversion is mathematically impossible, since $ds^2_{comoving\ clock}$ is a scalar invariant quantity, completely independent of the coordinates used to describe the clock trajectory, as we discuss in our paper and Supplement, and as Humphreys affirms in New vistas of space-time.[12]

Humphreys’ problem is that he never makes the effort to actually calculate the spacetime interval on comoving trajectories in his so-called ‘timeless region’.[13] If his new proposal were valid, such a calculation would explicitly result in $ds^2_{comoving\ clock} < 0$. Instead of performing this simple calculation, he simply assumes that the Euclidean signature of the Klein metric in this region requires that ds^2 be negative for all trajectories. Explicit calculation of $ds^2_{comoving\ clock}$ in the Euclidean region, as I have shown above (and as Dr Page and I discuss in our CEN Tech. J. paper and explicitly work out in the Supplement), shows that this is not so.

This brief analysis shows that Humphreys’ claimed discovery of a ‘timeless zone’ in the center of bounded locally homogeneous cosmology is a fantasy. Unfortunately, it is not possible to go further into the problems of New vistas of space-time in this brief letter.

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$$\beta(a,\eta=0)=\frac{\left[1-\frac{a_{max}}{a}\left(1-1-\eta^2_{edge}\right)^{3/2}\right]^2}{\left[1-\left(\frac{1-\sqrt{1-\eta^2_{edge}}}{\frac{a}{a_{max}}}\right)\right]^3} \quad \text{.................................. (8)}$$

$$d\tau_{comoving\ clock}=\frac{da}{c}\sqrt{\frac{a}{a_{max}-a}} \quad \text{.. (9)}$$

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6. Humphreys, Ref. 5, p. 203
7. Conner, S.R. and Page, D. N., 1997. The Big Bang Cosmology of Starlight and Time. Unpublished manuscript, 200+ pages, Appendix G.
8. Conner, S.R. and Page, D.N., 1998. Starlight and time is the big bang. CEN Tech. J. 12(2):174–194.
9. Conner and Page, Ref. 7.
10. The former occurs on the Klein metric signature change surface and the latter on the surface which Humphreys incorrectly identifies with the event horizon. The divergence and vanishing of b are artefacts of the Klein coordinate system and have no physical consequences for physical observers inside the matter sphere.
11. Humphreys, Ref. 5, p. 209.
12. Humphreys, Ref. 5, p. 197.
13. This is analogous to his failure in earlier versions of the Starlight and Time hypothesis to explicitly calculate the proper time elapsed on comoving clocks, a calculation which shows, as we demonstrate in our paper and Supplement, that there is no differential time dilation in the bounded matter sphere cosmology.