PHYS 472L #7#8

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1 #7

Consider a particle traveling with a velocity of $\beta = \frac{gt}{\sqrt{1+(gt)^2}}$ take its direction of travel to be the $\hat{x}$ and that it will pass thrugh the 4-origin.

Does this particle ever surpass the speed of light? Simply note that $\sqrt{1+(gt)^2} < gt$ therfore this fraction is always less than 1 for all t.

Lets compute the 4-velocity. $\gamma^-2 = 1 - \beta^2 = \frac{1}{1+(gt)^2}$ so $\gamma = \sqrt{1+(gt)^2}$ and $\tilde{u} = (\sqrt{1+(gt)^2}, gt, 0, 0)$.

We know that $\frac{dt}{d\tau} = u^0 \Rightarrow \tau = \int \frac{1}{\sqrt{1+(gt)^2}} dt$ now take $gt = sinh(\phi)$ so $\tau = \int \frac{\cosh(\phi)}{g\cosh(\phi)} d\phi = arcsinh(gt)/g$ (c is eliminated by IC). We can easily calculate $x(t) = \int \beta dt = \sqrt{1+(gt)^2}/g - 1$ (-1 is the constant that fufills the IC). $x(t) = \cosh(g\tau)/g - 1$

Lets find the 4-acceleration via $\gamma \frac{du}{dt} = \gamma(\frac{g^2 t}{\sqrt{1+(gt)^2}}, g, 0, 0) = (g^2 t, g\sqrt{1+(gt)^2}, 0, 0)$. Exactly what we got when we took the pure $\frac{du}{d\tau}$.

2 #8

Since in a particles instentanious rest frame u=(1,0,0,0) and we know that $\alpha \bullet u = 0$ we see that $\alpha = (0, a, 0, 0)$

In all frames the projection $u \bullet \alpha = 0$. So if we know u and one component of α, say α^0 we know $\alpha^0 u^0 / u^1 = \alpha^1$. Also the self projection of α onto itself must be constant, and originoly this is a^2 so $(\alpha^0)^2 + a^2 = (\alpha^1)^2$

This is similar to my statement above $\alpha^0 u^0 / \alpha^1 = u^1$.

$u \bullet u = 1$ (Tr=-2) (need to do proofs hw but can you show me where I went wrong???)