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4/15/22

HW3

1

3.1 $(\Delta \ell')^2 = (x_1'-x_2')^2 + (y_1'-y_2')^2 + (z_1'-z_2')^2$

$$= \gamma^2[x_1-x_2 - v(t_1-t_2)]^2 + (y_1-y_2)^2 + (z_1-z_2)^2$$

$$\Delta t' = t_1'-t_2' = \gamma\left[t_1-t_2 - \frac{v}{c^2}(x_1-x_2)\right]$$

$$(\Delta s')^2 = -c^2(\Delta t')^2 + (\Delta \ell')^2$$

$$(\Delta s')^2 = -c^2\gamma^2\left[t_1-t_2 - \frac{v}{c^2}(x_1-x_2)\right]^2 + \gamma^2[x_1-x_2 - v(t_1-t_2)]^2 + (y_1-y_2)^2 + (z_1-z_2)^2$$

(3.20) $$(\Delta s')^2 = -\gamma^2\left[c(t_1-t_2) - \frac{v}{c}(x_1-x_2)\right]^2 + \gamma^2[x_1-x_2 - v(t_1-t_2)]^2 + (y_1-y_2)^2 + (z_1-z_2)^2$$

$$(\Delta s')^2 = \frac{-\left[c^2(t_1-t_2)^2 - 2v(t_1-t_2)(x_1-x_2) + \frac{v^2}{c^2}(x_1-x_2)^2\right]}{\sqrt{1-v^2/c^2}^{\,2}}$$

$$+ \left(\frac{1}{\sqrt{1-v^2/c^2}}\right)^2\left((x_1-x_2)^2 - 2v(x_1-x_2)(t_1-t_2) + v^2(t_1-t_2)^2\right) + (y_1-y_2)^2 + (z_1-z_2)^2$$

$$(\Delta s')^2 = \frac{-c^2(t_1-t_2)^2 + \cancel{2v(t_1-t_2)(x_1-x_2)} - \frac{v^2}{c^2}(x_1-x_2)^2 + (x_1-x_2)^2 - \cancel{2v(t_1-t_2)(x_1-x_2)} + v^2(t_1-t_2)}{1-v^2/c^2}$$

$$(\Delta s')^2 = \frac{(t_1-t_2)^2(v^2-c^2) + (x_1-x_2)^2\left(-\frac{v^2}{c^2}+1\right)}{1-v^2/c^2} + (y_1-y_2)^2 + (z_1-z_2)^2$$

$$(\Delta s')^2 = \frac{(t_1-t_2)^2 c^2\left(\frac{v^2}{c^2}-1\right) + (x_1-x_2)^2(1-v^2/c^2)}{1-v^2/c^2} + (y_1-y_2)^2 + (z_1-z_2)^2$$

(3.21) $$(\Delta s')^2 = -c^2(t_1-t_2)^2 + (x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2$$

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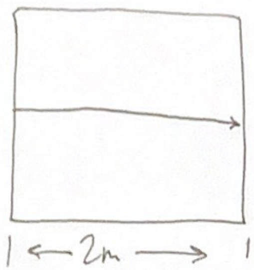
3.2



(2)

$y = y_0 + v_{0y}t + \frac{1}{2}at^2$

$\Delta y = \frac{-g}{2}t^2$

$\Delta y = \frac{-9.8}{2}(6.67 \times 10^{-9} s)^2$

$\Delta y = -2.18 \times 10^{-16}\ m$

(1)

$x = x_0 + v_{0x}t$

$2m = ct$

$t = \frac{2m}{c} = \frac{2m}{3.00 \times 10^8 m/s} = 6.67 \times 10^{-9} s$

$\therefore$ The downward deflection of a light ray across a 2m box is $\sim 2 \times 10^{-16}\ m$.

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HW 3

3.3 $$dl^2 = \frac{d\bar{x}^2}{1 - K\bar{x}^2/R^2} + \bar{x}^2 d\Omega^2$$

$\bar{x} = S_K(r)$

$d\bar{x} = \frac{d}{dr} S_K(r) dr$

$K=+1$: $$dl^2 = \frac{\cos^2(r/R) dr^2}{1 - R^2\sin^2(r/R)/R^2} + R^2 \sin^2(r/R) d\Omega^2$$

$$dl^2 = \frac{\cos^2(r/R)\, dr^2}{\cos^2(r/R)} + R^2\sin^2(r/R) d\Omega^2$$

$$dl^2 = dr^2 + S_K(r)^2 d\Omega^2 \checkmark$$

$K=0$: $$dl^2 = \frac{dr^2}{1} + r^2 d\Omega^2$$

$$dl^2 = dr^2 + S_K(r)^2 d\Omega^2 \checkmark$$

$\cosh^2 x - \sinh^2 x = 1$

$1 + \sinh^2 x = \cosh^2 x$

$k=-1$: $$dl^2 = \frac{\cosh^2(r/R) dr^2}{1 + R^2 \sin^2 h(r/R)/R^2} + R^2\sinh^2(r/R) d\Omega^2$$

$$dl^2 = \frac{\cosh^2(r/R) dr^2}{1 + \sinh^2(r/R)} + R^2 \sinh^2(r/R) d\Omega^2$$

$$dl^2 = \frac{\cosh^2(r/R) dr^2}{\cosh^2(r/R)} + R^2\sinh^2(r/R) d\Omega^2$$

$$dl^2 = dr^2 + S_K(r)^2 d\Omega^2 \checkmark$$