

# PHYS 480/581 General Relativity

## Extra Problems #2

### Question 1.

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Imagine that space (not spacetime) is actually a three-torus with size  $L$ . By this we mean that there is a coordinate system  $(t, x, y, z)$  such that every point with coordinates  $(t, x, y, z)$  is *identified* with every point with coordinates  $(t, x + L, y, z)$ ,  $(t, x, y + L, z)$ , and  $(t, x, y, z + L)$ . Note that the time coordinates is the same.

Now consider two observers; observer  $A$  is at rest with respect to this coordinate system, while observer  $B$  moves in the  $x$ -direction with constant velocity  $v$ .  $A$  and  $B$  begin at the same event, and while  $A$  remains still,  $B$  moves around the universe and comes back to intersect the worldline of  $A$  without ever having to accelerate (since the universe is periodic).

What are the relative proper times experienced in this interval by  $A$  and  $B$ ? Is this consistent with your understanding of Lorentz invariance?

### Question 2.

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Three events  $A$ ,  $B$ , and  $C$ , are seen by observer  $\mathcal{O}$  to occur in the order  $ABC$ . Another observer,  $\bar{\mathcal{O}}$ , sees the events to occur in the order  $CBA$ . Is it possible that a third observer sees the events in the order  $ACB$ ?