INVARIANCE OF THE RELATIVISTIC INTERVAL

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References: Kip S. Thorne & Roger D. Blandford, *Modern Classical Physics*, Princeton University Press (2017). Exercise 2.2.

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In their Box 2.4, T&B give a derivation of the invariance of the relativistic interval, so that

$$(\Delta s)^2 = -(\Delta t)^2 + (\Delta x)^2 + (\Delta y)^2 \tag{1}$$

$$= -\left(\Delta t'\right)^2 + \left(\Delta x'\right)^2 + \left(\Delta y'\right)^2 \tag{2}$$

$$= \left(\Delta s'\right)^2 \tag{3}$$

The derivation relies on showing, first, that their equation (1b) in Box 2.4 follows from the same argument as equation (1a) (which they effectively show in their hint to the question; it's just a matter of going through their derivation again in the primed frame, which is essentially the same), and that there is no Lorentz contraction in distances perpendicular to the relative motion. The best argument I've seen for proving the latter was described earlier, so I refer the reader to that post.

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