List of Errata to
A First Course in General Relativity (2nd Edition)
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Chapter 1

Special Relativity

Problem 15. Suppose that the velocity v of Âŕ $\bar{O}$ relative to O is nearly that of light, $|\mathbf{v}| = 1 - \epsilon$, $0 < \epsilon < 1$. Show that the same formulae of Exer. 14 become:

$$\begin{aligned}
(a) \quad & \Delta t \approx \frac{\Delta \bar{t}}{\sqrt{2\epsilon}} \\
(b) \quad & \Delta x \approx \frac{\Delta \bar{x}}{\sqrt{2\epsilon}} \\
(c) \quad & w' \approx 1 - \epsilon \frac{(1-w)}{(1+w)}
\end{aligned} \tag{1.1}$$

Correction:

$$(b) \quad \Delta x \approx \Delta \bar{x} \sqrt{2\epsilon} \tag{1.2}$$

Problem 18. (b) Use this to solve the following problem. A star measures a second star to be moving away at speed $v = 0.9c$. The second star measures a third to be receding in the same direction at 0.9c. Similarly, the third measures a fourth, and so on, up to some large number N of stars. What is the velocity of the Nth star relative to the first? Give an exact answer and an approximation useful for large N.

Error:

The (partial) solutions manual provides the answer as:

$$v_{N,1} = \tanh[(N \times \operatorname{arctanh}(0.9)] \tag{1.3}$$

Correction:

Since the speed of the second star with respect to the first star is $v_{2,1} = 0.9$ ($c = 1$), the velocity parameter is $u_1 = \operatorname{arctanh}(0.9)$. Now, the speed of the third star with respect to the second star is $v_{3,2} = 0.9$, assuming they're all moving away from the first star in the same direction. This makes the velocity parameter $u_2 = \operatorname{arctanh}(0.9)$. Inductively, the velocity parameter of the N^{th} star with respect to the $(N-1)^{th}$ star will be: $v_{N,N-1} = 0.9 \implies u_{N-1} = \arctan(0.9)$
The velocity of the third star with respect to the reference frame of the first star is:

$$v_{3,1} = \tanh(u_1 + u_2) = \tanh(\operatorname{arctanh}(0.9) + \operatorname{arctanh}(0.9)) = \tanh(2\operatorname{arctanh}(0.9)) \tag{1.4}$$

Since velocity parameters add linearly, we can show that:

$$\sum_{i=1}^{N-1} u_i = \operatorname{arctanh}(v_{N,1}) \tag{1.5}$$

Performing induction for N stars, the speed of the Nth star with respect to the first star is:

$$v_{N,1} = \tanh\left(\sum_{i=1}^{N-1} u_i\right) = \tanh[(N-1) \times \operatorname{arctanh}(0.9)] \tag{1.6}$$