Ex Relative Velocity

Two ships approach Earth from opposite directions. If each ship moves at 0.60c relative to Earth, how fast do they move relative to each other?

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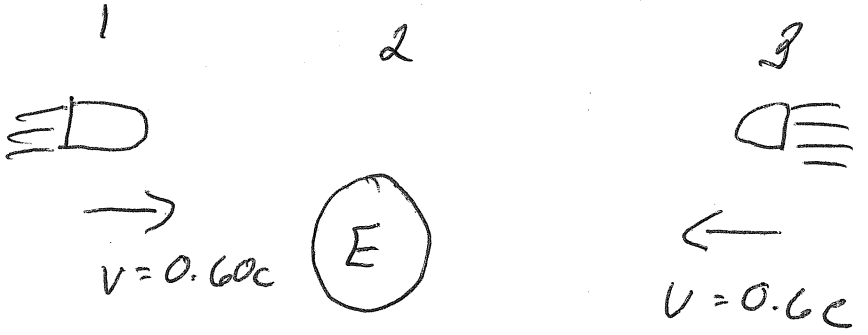

$V_{12} = 0.60c \Rightarrow V_{21} = -0.60c$

$V_{32} = -0.60c \Rightarrow V_{23} = 0.60c$

$V_{13} = ?$

$$V_{23} = \frac{V_{21} + V_{13}}{1 + \frac{V_{21} V_{13}}{c^2}}$$

$$V_{13} = \frac{V_{23} - V_{21}}{1 - \frac{V_{23} V_{21}}{c^2}} = \frac{0.60c - (-0.60c)}{1 - \frac{(0.60c)(-0.60c)}{c^2}}$$

$$= 0.882c$$

$$\boxed{0.88c}$$

Ex Relative Velocity.

A rocket travels toward an ~~moon~~ Earth base at 0.90c. The rocket releases a probe that moves at 0.10c relative to it in the opposite direction. What is the velocity of the probe relative to Earth?

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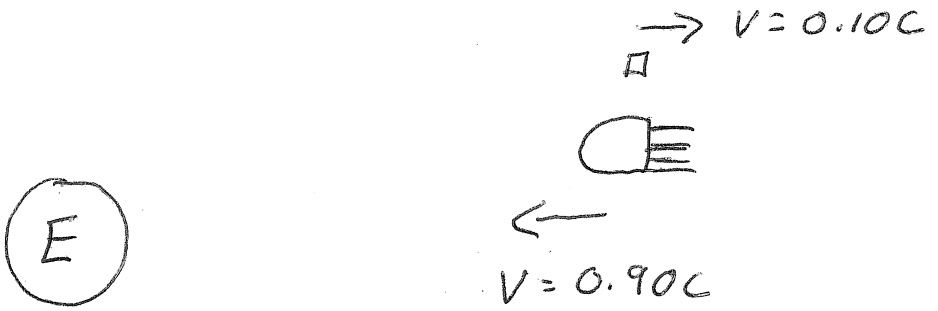

Earth 1
Ship 2
Probe 3

$V_{31} = ?$ $\Rightarrow V_{13} = -V_{31}$

$V_{21} = -0.90c$

$V_{32} = 0.10c$ $\Rightarrow V_{23} = -0.10c$

$$V_{23} = \frac{V_{21} + V_{13}}{1 + \frac{V_{21} V_{13}}{c^2}}$$

$$V_{23}\left(1+\frac{V_{21}V_{13}}{c^2}\right)=V_{21}+V_{13}$$

$$V_{23}+\left(\frac{V_{23}V_{21}}{c^2}\right)V_{13}=V_{21}+V_{13}$$

$$V_{23}-V_{21}=V_{13}-\left(\frac{V_{23}V_{21}}{c^2}\right)V_{13}$$

$$\frac{V_{23}-V_{21}}{1-\frac{V_{23}V_{21}}{c^2}}=V_{13}$$

$$\frac{(-0.10c)-(-0.90c)}{1-\frac{(-0.10c)(-0.90c)}{c^2}}=V_{13}=\boxed{(8.79E-1)c \text{ or } 2.64E8\ m/s}$$