

FTL time reversal

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1 According to Einstein's Theory of special relativity, anything that travels faster than light travels back in time.

The equation in Einstein's theory of special relativity that illustrates how faster-than-light (FTL) travel could lead to time reversal or causality violations arises from the **Lorentz transformations**, specifically the transformation of time intervals between reference frames. Here's the key reasoning:

Key Equation: Time Transformation in Lorentz Transformations The time difference between two events in a moving frame S' is given by:

$$\Delta t' = \gamma \left(\Delta t - \frac{v\Delta x}{c^2} \right),$$

where: - Δt and Δx are the time and spatial separation between events in the original frame S , - v is the relative velocity between frames S and S' , - $\gamma = \frac{1}{\sqrt{1-v^2/c^2}}$ is the Lorentz factor.

Implications for Faster-Than-Light Travel 1. **Causality Reversal**: Suppose that an object travels at speed $u > c$ (superluminally) in frame S , so $\Delta x = u\Delta t$. Substituting into the time transformation:

$$\Delta t' = \gamma\Delta t \left(1 - \frac{vu}{c^2} \right).$$

For $u > c$, there exists a $v < c$ such that $\frac{vu}{c^2} > 1$. This makes $\Delta t' < 0$, reversing the temporal order of events in S' .

2. **Spacelike Intervals**: Events separated by FTL signals (spacelike intervals, $\Delta x > c\Delta t$) allow observers in different frames to disagree on event ordering. This violates causality if effects precede causes.

Conclusion The critical term $\left(1 - \frac{vu}{c^2} \right)$ in the time transformation equation shows that **superluminal motion** ($u > c$) can lead to negative time differences ($\Delta t' < 0$) in certain reference frames, implying time reversal. While no physical object can exceed c , this mathematical result underscores why FTL travel is incompatible with causality in special relativity.