

6.1: Light Speed- Limit on Casualty

no signal reaches us faster than light

Signal Sun with super speed?

Nine-year-old Meredith waves her toy magician's wand and shouts, "Sun is exploding right now!" Is she right? We have no way on Earth of knowing - at least not for a while. Sun lies 150,000 million meters from Earth. Therefore it will take 150,000 million meters of light-travel time for the first light flash from the explosion to reach Signal Sun with super speed? us. This equals 500 seconds - 8 minutes and 20 seconds. We will just have to wait and see if Meredith is correct...¹

When 8 minutes and 20 seconds pass, we have evidence that Meredith was mistaken: Looking through our special dark glasses, we see no exploding Sun.

But Meredith's wand has started us thinking. What in the laws of nature prohibits the wave of her wand from being the signal for Sun to explode at that same instant? Or - more reasonably, given the awesome event - what prevents Meredith from having instantaneous warning, so that she raises her wand simultaneously with Sun's explosion in order to give us (in light of later developments) a false impression of her power?

No, just speed of light

Both questions have the same answer: "The speed of light." Whatever her powers, Meredith cannot affect Sun in less than 500 seconds; neither can a warning signal reach us from Sun in less time than that. All during that intervening 500 seconds we would see the accustomed round shape of Sun, apparently healthy as ever.²

More generally, one event cannot cause another when their spatial separation is greater than the distance light can travel in the time between these events. Light speed sets a limit on causality. No known physical process can overcome this limit: not gravity, not some other field, not a zooming particle of any kind. "Spacetime interval" quantifies this limit on causality. Interval between far-away events - unlike distance between far-away points - can be zero. In this and other ways the spacetime geometry of the real world differs fundamentally from the space geometry of Euclid's 2300 year-old textbook.

1 Signal Sun with super speed?

2 No, just speed of light

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