9.8: Wrapping It Up 9 - A Trip to Alpha Centauri

Learning Objectives

- You will be able to put everything together to demonstrate your understanding of special relativity, using spacetime diagrams.

> *"The views of space and time which I wish to lay before you have sprung from the soil of experimental physics, and therein lies their strength. They are radical. Henceforth space by itself, and time by itself, are doomed to fade away into mere shadows, and only a kind of union of the two will preserve an independent reality." —H. Minkowski, 1908*

Imagine you want to travel to Alpha Centauri, the nearest star to the Sun. The star is 4.2 light-years away, so it takes light from the Sun 4.2 years to reach Alpha Centauri, and vice versa. Figure A.9.6 shows the Sun and Alpha Centauri, along with some other distant stars.

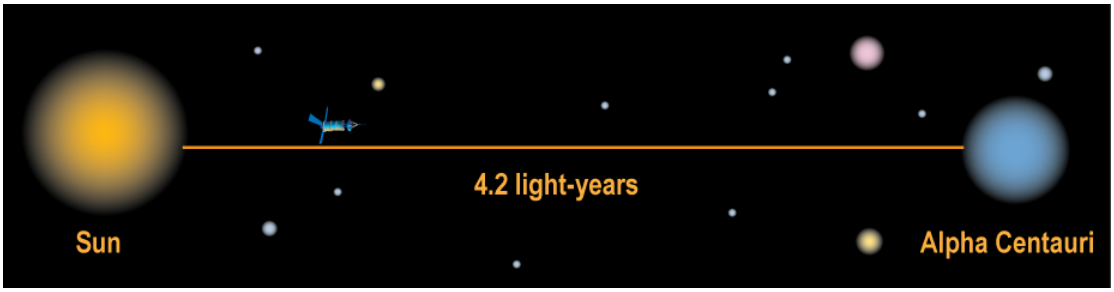

Figure A.9.6: The Sun and Alpha Centauri, with a few distant stars in the background. The distance between the two is 4.2 light-years. The digram is not to scale. Credit: NASA/SSU/Aurore Simonnet

Imagine that you have a spaceship that can travel at half of the speed of light. Traveling at that speed, it would require 8.4 years to reach Alpha Centauri. We will use the *Spacetime DiagramTool* to explore how you would experience the trip if you were a passenger on the ship. You will also need the clickable gamma graph.

Play Activity

USE GRAPH

9.8.1: Part I: The Spacetime Interval between Two Events

The first event is your departure from the Sun/Earth, and the second is your arrival at Alpha Centauri. Each of these events can be represented by a single point in a spacetime diagram.

1. Use the velocity slider bar to create a set of t'- and x'-axes for a frame traveling at 0.5c, the speed of your spaceship.

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In your frame of reference, you should notice that the entire spacetime interval is made up of the time you measure for the star to arrive. In the reference frame of the Earth, there are both space and time components to the trip.

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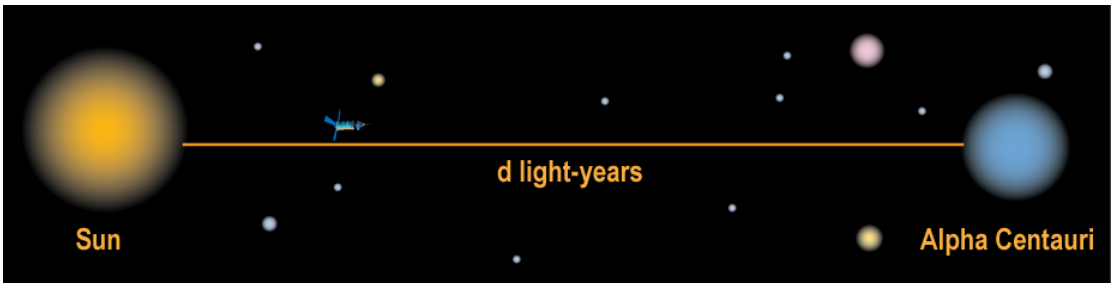

Figure A.9.7: The Sun and Alpha Centauri, with an unknown distance between the stars, due to the length contraction perceived by the traveler on the spaceship. Credit: NASA/SSU/Aurore Simonnet

9.8.2: Part II: Energy of Trip

We cannot make the trip described in this activity with our current technology. In this part, we will explore part of the reason for this limitation. We imagined that our spaceship could travel at half of the speed of light. The relativistic gamma factor for this speed was 1.15.

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