

28C The Time Machine

How long does it take for starlight to reach Earth?

Light travels very fast at 300,000 kilometers per second. However, the universe is very large. Light that reaches your eyes from distant stars or galaxies has been traveling for a long time. Suppose you look through a telescope and see a galaxy that is one million light-years away. Because it takes one million years for the light to reach you, you are actually seeing the galaxy as it was one million years ago! Looking out into the universe is like looking back in time. The farther away you look in space, the farther back you see in time.

Materials

- Astronomy reference materials

1 How fast is fast?

When you travel in a car or a jet, your speed is usually measured in miles per hour or kilometers per hour. It takes about six hours to fly across the country on a modern airliner, which travels about 1000 km/hr. This is about as fast as a person can travel today, but it is nothing compared to how fast light travels.

Complete Table 1 below and compare the speeds of these fast moving objects to the speed of light (rounded to the nearest 300,000 km/sec). To calculate the percent of speed of light;

$$\frac{\text{Speed of object}}{\text{Speed of light}} \times 100 = \text{Percent of speed of light}$$

Table 1: Comparing speeds

Object	Speed in km/hr	Speed in km/sec	Time to reach the moon 384,400 k m away (hours and days)	% of speed of light
Diving falcon	250			
Mag-Lev Train	430			
Top fuel dragster	535			
Commercial jet	1000			
Space shuttle	28,000			
Comet	200,000			

- a. Earth is about 150,000,000 km from the sun. How long does it take the light from the sun to reach Earth?

- b. Jupiter is 778,000,000 km from the sun. How long does it take the light from the sun to reach Jupiter?

- c. Pluto is 5,900,000,000 km away from the sun, the farthest planet away. How long does it take light from the sun to reach Pluto?

2 How far is far?

When we looked the size of the solar system we saw that the distances between the planets were enormous in comparison with the distances we experience in our everyday lives here on Earth. In the study of the universe scientists often use the term light year as a measure of distance. This represents the distance light travels in one year, and since light is moving at 300,000 km/sec the distance adds up quickly. How quickly? Fill in Table 2 to find out.

Table 2: Light year data

Unit	Speed of light (in km/sec)		Time in seconds	Distance (in km)
1 light second	300,000	x	1	300,000
1 light minute	300,000	x	60	
1 light hour	300,000	x		
1 light day	300,000	x		
1 light week	300,000	x		
1 light year	300,000			

3 Looking back in time

The light from the sun that we see took several minutes to get here, even at the amazingly fast speed that light travels. But the light we see from stars takes much, much longer. Scientists measure the distances to objects like stars and planets outside our solar system in units of light years because the distances between objects in space is so huge. In fact, the closest star to Earth (other than our sun) is Alpha Centauri, which is 4.3 light years away. The light from that star took 4.3 years to get to us, so it is like looking back a little over four years into the past. The further objects are from Earth the longer the light takes to get to us, and the further back in time we are looking. When an astronomer looks at Alpha Centauri she is not seeing Alpha Centauri as it is right at this second, she is seeing it as it was 4.3 years ago.

Most of the stars we see in the night sky reside right here with us in the Milky Way galaxy. The ones that are not are actually galaxies that are very, very far away.

Research these night sky objects and see if you can locate them to look back in time.

Table 3: Night sky objects

Object	Distance from Earth (light years)	Years looking back in time
Sirius		
Vega		
Arcturus		
Canopus		
Polaris		
Betelgeuse		
Rigel		
Andromeda Galaxy (M31)		