

Frequently Asked Questions

1. Does a telescope affect my look-back time?

Before we begin let's be sure to define our terms. What is meant by look-back time? Well light travels at a constant speed, it does not instantaneously travel through space (although it moves very fast 670,616,629.4 miles per hour). That means that there is a *very* small amount of time between when a lightbulb across the room starts emitting light and it reached your eye. That means that all the information we have from the lightbulb is actually from some time in the past. Now in a room or for any distance that we ever encounter here on earth, light travels so fast that it appears to us as instantaneous. However, in astronomy, we deal with distances that are so incredibly large this actually has an effect on what we see. For instance all the light from our sun takes 8 minutes to reach earth. That means that all the information we have about our sun is exactly 8 minutes old. So if the sun magically disappeared, we would have no way of knowing about it for 8 minutes!

The only information we have from stars is the light we receive from them. We can't hear, taste, touch, or smell them. So it becomes important to consider how this look back time phenomenon affects our observations. To make things easier astronomers have devised a unit of length, like a meter or a yard, where we define 1 light-year as exactly the distance light will travel in one year. This means that if we look at a star that is 1000 light years away, it has taken light from that star 1000 years to reach us and hence we are looking at the star as it was 1000 years ago. *When looking at distant objects, astronomers are looking back in time!* This is what allows us to study our universe at a variety of times and stages in its evolution.

So to now examine our question: Does looking through a telescope affect our look back time? Well a telescope acts as a focuser of light. It takes light from a small section of the sky and collects it so that we can see that portion of the sky better. The photons that reach the telescope took just as long to get there as ones that get to your eye because they traveled the same distance. The speed of light is the same and the distance is the same, so the look-back time must be the same. The telescope just acts to collect more of them together so we can get a better, clearer picture.

2. In a galaxy or cluster of stars, is there one massive object that is pulling everything in?

This is a complicated question that a lot of people have problems with initially because it explores a more detailed description of gravity than many people encounter in their day-to-day lives. In our solar system, we have a central object in the center, the sun, that holds our solar system together. And here on earth, the mass of our planet is what keeps us from floating out into space. This is how it appears to work but in reality things are slightly more complicated.

To begin lets consider a case where we had 2 stars, each is exactly like our

sun. Most importantly, these two stars have exactly the same mass. Now let's consider a stable configuration for these stars. Let's initially assume that both stars are at rest. Neither is moving with any velocity. What is going to happen? Well, both stars have mass, so gravity is going to want to pull them together. The two stars will gradually start to accelerate towards each other until they collide. So that isn't very stable!

So what actually happens? There are binary stars in our galaxy, so how are they stable? One might think that one of the stars will orbit the other like the earth orbits the sun but that is not how it works. Both stars will actually orbit around each other, specifically they will orbit around their common center of mass. So what is a center of mass? Imagine you put each planet on opposite ends of a see-saw. The center of mass is the place where you would have to put the pivot point (also known as the fulcrum) in order to make the see-saw balanced.

So that means that in a large cluster of stars or a galaxy, all of the stars are being pulled toward the center of mass of the system.

To just complicate everything even further and make your lives more complicated, many galaxies (including our own) actually have a very massive black hole in the center. However this is *not* what is holding the whole galaxy together!

How does the Earth through space and how does it affect us?

So in class we went over all the different motions of the Earth and it can get kinda confusing. So here is a quick recap:

Over the course of one calendar year the Earth orbits around the sun. The Earth is tilted with respect to the sun, depending on the time of the year, either the Northern or Southern hemisphere receives light from the sun for a longer period of time. This is what is responsible for our seasons. This is also why when it Summer in the Northern hemisphere it is winter in the Southern. (Note: The seasons are not caused by the Earth moving closer or farther away from the sun. While the Earth's orbit is not a perfect circle and at times its distance from the sun changes over the course of the year, this effect is not responsible for the seasons.)

Now over a very long time-scale, around 28 thousand years, the tilt of the Earth's axis precesses around like a spinning top. This precession has little effect on our lives as it occurs so slowly as to be barely noticable for us and does not make a significant change to the seasons over the course of our lifetimes.

Our Sun and solar system also are moving around their home galaxy, Milky Way. We move around the entire galaxy once every 220 million years. The entire solar system and sun are moving roughly at 200 kilometers per second, but we don't feel this motion, because everything that we see like the sun, moon, and planets are moving with us.