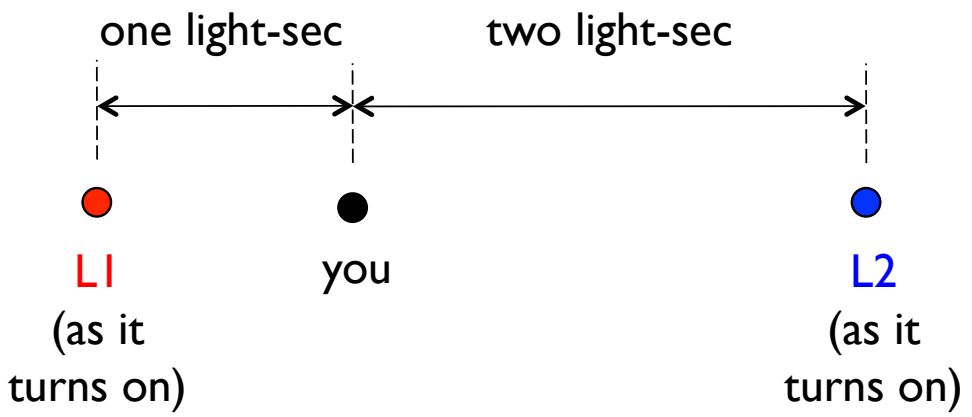
TWO SIZES on the COSMOLOGICAL TIME LINE

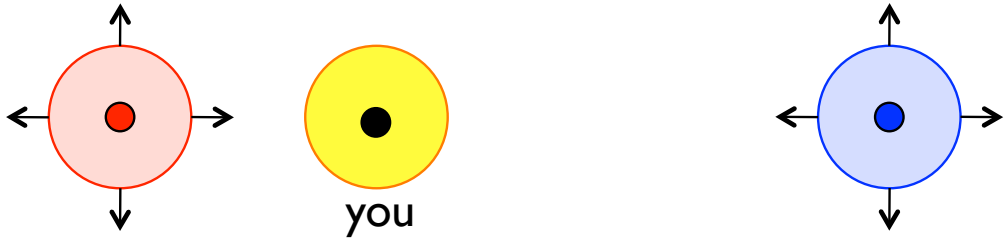
When you look on the Cosmological Time table, you will notice that there are two sizes quoted when talking about the universe, one identified as "event horizon" and one as "the stuff we can see now." A little explanation is in order.

Let's assume you are sitting in space. A light source L1 is *one light-second* to your left (a light-second is the distance light travels in one second) and on your right is a second light source L2 that is *two light-second* away. Both are moving *away from you* at very low speed, and both turn on their respective lights at t = 0. The sketch below depicts the situation at t = 0.

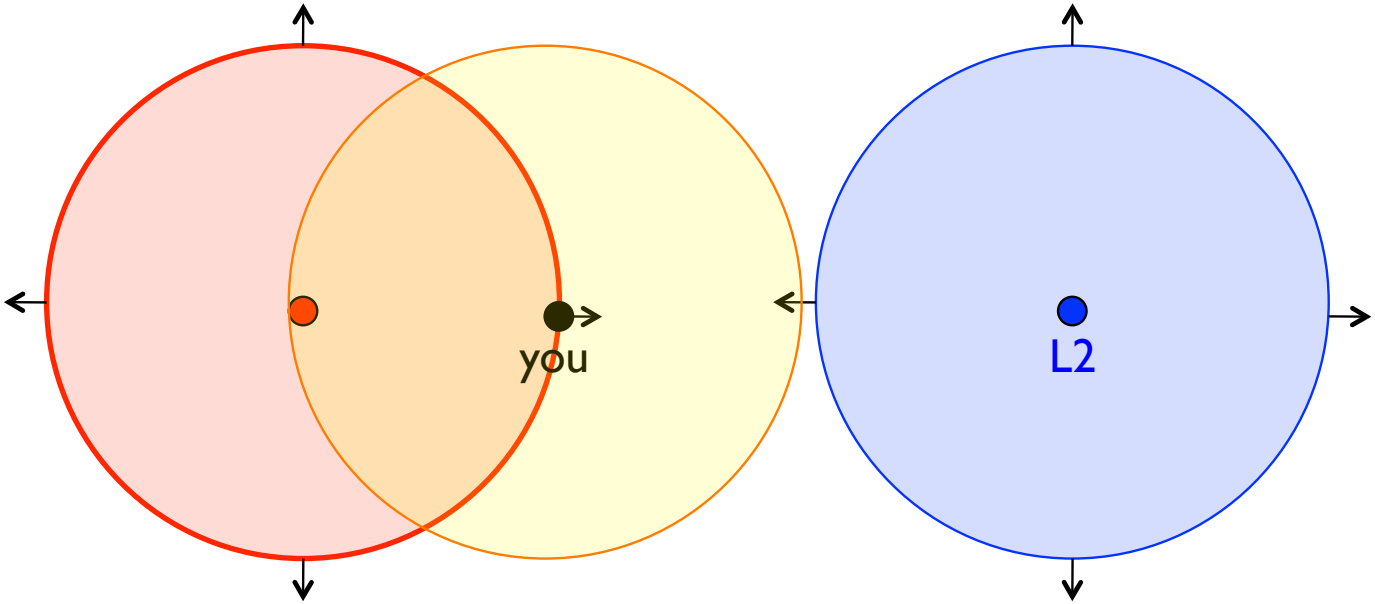


Initially, you don't know either source exists as the light from neither has reached you, so your "known universe," encompassed by what is called your "event horizon," does not include them. But what happens as time proceeds?

Remember, the sources are assumed to be moving very, very slowly (that means they will not appear to be moving in our sketch, given its scale). After a third of a second, the edge of the light cones from each light source will have moved out from the source and look as shown below. As those edges haven't yet passed by your position, you still aren't aware of the existence of L1 and L2--they still aren' t inside your *event horizon*, which is denoted by the yellow circle (it would be a sphere in three dimensions) around "you."



At *one light-second,* the light from L1 finally reaches you. With its light evident to you, you "see" the source as being inside your event horizon (again, the yellow circle) and you consider it to be a part of your known universe. The light from L2 hasn't yet had time to reach you, though, so is still way outside event horizon and is not a part of your current, known universe.



In other words, if we assume the universe is expanding slowly, how big the universe appears to be is related to how old it is, because that has to do with how long light has had to travel through space to get to us.

Sooo, if you look on the Cosmological Time Line at 10^{-10} seconds after the Big Bang and you find that the "event horizon" was 6 centimeters, that means that at that point in time, light would have had time to move only 6 centimeters maximum and the only "stuff" you would be aware of (assuming you *could* have been aware of stuff at that point) would have been stuff within a 6 centimeters radius.

But is that a lot of stuff or little stuff in comparison to the stuff that inside our event horizon now? To make the comparison, I've additionally included how far out all the stuff was at that time that we *now* can see. In the 10^{-10} second case, all the stuff within our current event horizon now existed a distance out equal to the distance between the sun and Pluto.

That is why the Cosmological Time Line lists two "size" quantities to enumerate how big the universe was at various points in time after the Big Bang.

There is one fly in the ointment, though, which anyone who bothered to do the math would notice. Light traveling at $3\text{x}10^{8}\,\text{m/s}$ for 10^{-10} seconds should only travel 3 centimeters. Yet the claim is that it traveled 6 centimeters. So what's up?

The answer is that right at the end of the Planck era, it is believed that the universe actually expanded faster then the speed of light (this is called "inflation").

No, this doesn't violate Einstein's Theory of Relativity and, clearly, inflation is something we have to talk about more. That is coming!