2.1

JACQUELINE HOWARD PRESENTS: LOOKING INTO THE PAST

0:12-0:45

LOOKING BACK IN TIME

It's a universal truth. No matter where you live or how many stars you're able to see, when you look out into space, you're looking back in time. Space and time are intertwined. How's that possible? How is the Universe basically all history? Here are two key principles about the Universe that will answer those questions.

Hey everyone, Jacqueline Howard here. We're kicking things off with what just may be the most important principle of all: the speed of light. It's the secret to our understanding of space and time.

0:45-1:49

SPEED OF LIGHT

See, light travels at a constant speed of 186,000 miles per second. That's fast. At that speed, you could circumnavigate the Earth's equator seven-and-a-half times in a single second. You could travel six trillion miles in one year, and there's even a name for that. It's one light year, and it's the metric in which we measure the Universe since space is so vast.

For instance, most of us can find a group of stars known as the Big Dipper in the night sky. Now the two stars that make up the outer part of the Big Dipper's bowl will always point you directly to the North Star, Polaris, which is 323 light years from Earth. That means that the light that leaves Polaris today will reach Earth in 323 years. In other words, the light that we will see from the North Star tonight left the star 323 years ago. That's around the same time that the Salem witch trials went down.

1:49-2:44

EXPANDING UNIVERSE

Now here's the second principle to consider: the Universe is expanding. Expanding from where? Well, that's the tricky part. From everywhere. Think of it this way: we're a part of the Milky Way galaxy, which, in our cosmic address, belongs within our "local group" of nearby galaxies. Think of our local group and neighboring groups as the dots on this balloon. And think of space as the distance between the dots. Now watch what happens. See how space seems to expand in all directions? That's how the Universe works. That's "everywhere" expanding.

Galaxies are all receding and they've been doing so because of the Big Bang, 13.82 billion years ago. The space between the galaxies is expanding just

like we saw on our balloon. But the galaxies themselves are basically stationary.

2:44-3:28

DOPPLER EFFECT

This universal expansion certainly isn't over. It's still going on as astronomer Edwin Hubble discovered in the late 1920s. He found important evidence to support Big Bang cosmology and the continued expansion of the Universe.

You see, since light travels in waves, much like sound, it is subject to a Doppler effect just like sound waves are. You know the Doppler effect; you hear it every time an ambulance passes by. When an ambulance approaches, the sound of its siren seems to get higher in pitch as the sound waves are propelled toward your ears and wavelengths are slightly shortened. After it passes, the pitch drops, as it drags the sound waves away, pulling them away from your ears, and stretching them out.

3:28-4:33

REDSHIFTED

Light waves stretch in the same way as galaxies recede away from us, but as they stretch, they slightly shift in color, not pitch. Picture the visible light spectrum-- you know, the colors of the rainbow, ROY-G-BIV. When a galaxy is receding from you, due to the expansion of space between you and the galaxy, the light that its stars emit shifts to the red end of the spectrum. That's because the light wavelengths get longer. It's redshifted.

Light waves moving closer to you shift to the blue end of the spectrum. That's because the wavelengths get shorter. Hubble noticed that virtually all of the distant galaxies, when observed from Earth, were redshifted. That provides evidence that they are receding away from us as the Universe expands. He also noticed that the farther the object from Earth, the more pronounced the redshift of its light, which suggests the object is receding at a higher speed. Incredible.

The Universe has expanded to such depths that the light from some stars doesn't reach us until after that star has already perished. Stars' lives unfold before our eyes each night long after they're gone. So our exploration of deep space is only limited by our own visual capabilities, which are becoming more and more advanced with new developments in space telescope technology.

4:33-5:25

HUBBLE SPACE TELESCOPE

One development was launched in 1990: the Hubble Space Telescope, named after the guy who taught us about the Universe's expansion. Thanks to this telescope, we've seen spectacular snapshots of our neighboring spiral galaxy Andromeda, which is 2.5 million light years away. That gives us a glimpse of how the Universe was 2.5 million years ago.

And with Hubble's infrared and ultraviolet sensors, we have an image that's called the deepest look into our Universe to date. That was published in 2012, and it's dubbed "the eXtreme Deep Field." It shows 5,500 galaxies that span back 13.2 billion years in time. That allows us to observe light from some of the earliest galaxies and stars that ever formed.

5:25-6:42

JAMES WEBB SPACE TELESCOPE

Wow, Hubble's done some cool things, but currently, there's a team of aerospace and electrical engineers at NASA who are building the Hubble's successor, the James Webb Space Telescope. The James Webb's mirror, or essentially its eye, is seven times bigger than the Hubble's. The entire telescope itself will be the size of a passenger jet. Meanwhile, the Hubble is only about the size of a school bus. The goal of this new telescope is to see the first stars of the Universe after the release of what's called the cosmic microwave background radiation, just 380,000 years after the Big Bang. But don't worry, a 2018 launch date has been set for the telescope.

You better stay tuned.