

Evolution of the Universe: What would the evidence look like?

In this part of the unit you are going to use what you have learned so far about waves to decide which theory or theories about the formation of the universe are better supported by scientific evidence.

At this point you should understand that studying the light coming from an object in the universe can allow us to know whether this object is moving away from us, toward us, or not moving at all. Scientists used these ideas to explain whether the universe was expanding (galaxies and stars would move away from us), contracting (galaxies and stars would move closer to us) or static (the distance among galaxies and stars would remain constant).

Make the following predictions about what you would expect to see for each of these alternative scenarios. A prediction is not a guess. You need to use your understandings about the doppler effect in order to justify them.

For example, if the universe were expanding, what kind of change in the light waves frequency would you see? Would the light observed shift toward the red or the blue side of the spectrum?

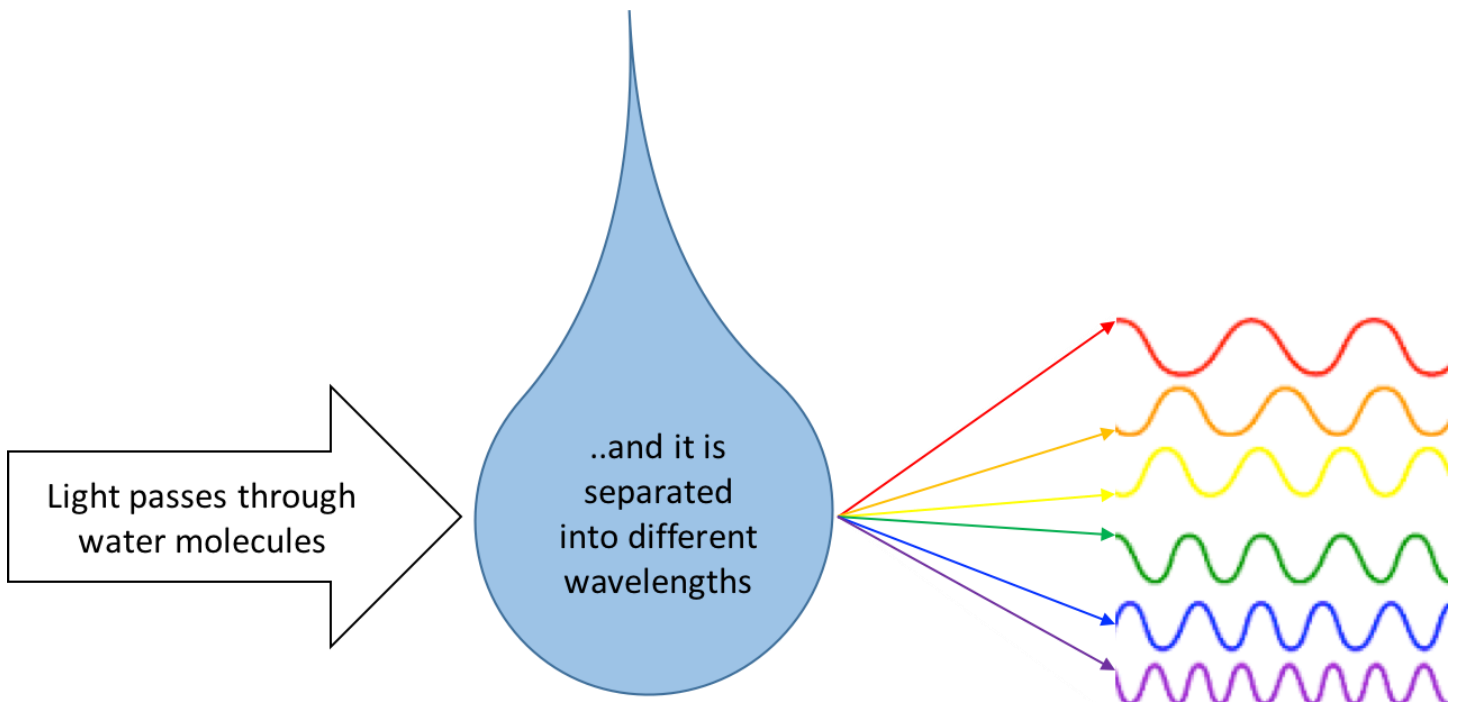
The universe is expanding (everything is moving apart) :

The universe is contracting (everything moving closer together) :

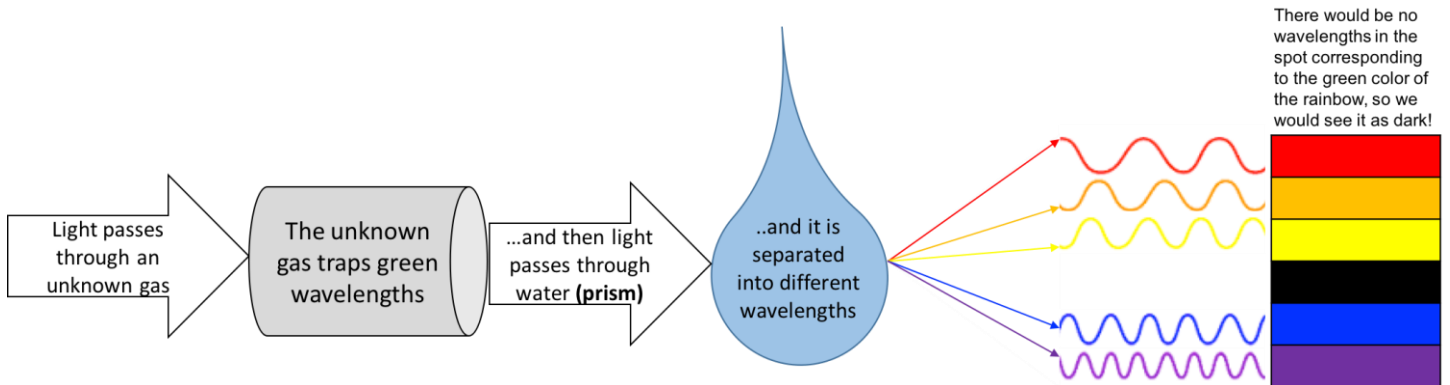
The universe is static (not moving):

Absorption Lines in Electromagnetic Light Spectra

Before you analyze some of the evidence used to solve this scientific debate, you need to understand one more thing. You are probably familiar with the rainbow that appears when it rains during a sunny day. This happens because the light coming from the Sun passes through raindrops, where water molecules arrange light into different wavelengths. The image below represents what happens when light passes through a raindrop.

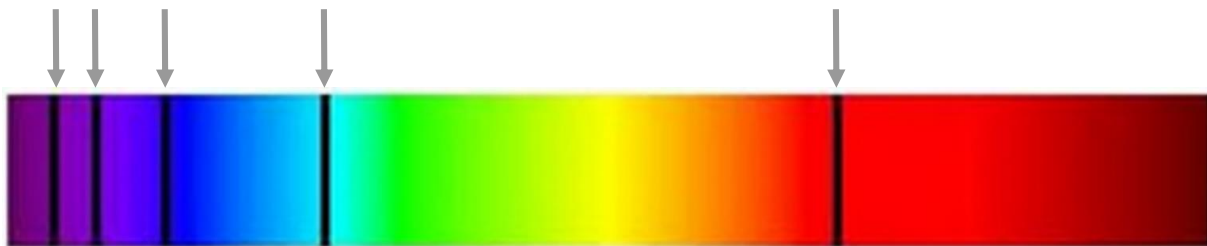


However, when light passes through other substances (instead of water), the molecules of such substances can absorb some of the wavelengths of light, and you will see gaps in the spectrum that corresponds to these wavelengths. For example, if light passes through a gas that absorbs wavelengths that we perceive as green, you would see a whole in the rainbow in the corresponding green color, like the image below:



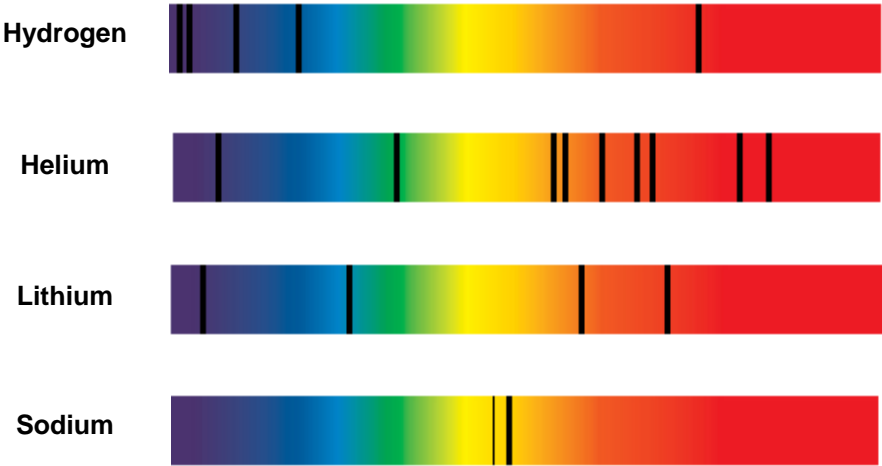
Note that we added the word **prism** into the second arrow. Similar to water, a prism is an object that divides light into different wavelengths. Scientists noted that when light passes through a tube of hydrogen gas and then through a prism (which similar to water molecules, organizes light into different wavelengths), there were lines missing from the light spectrum:

Absorption lines: these gaps correspond to the wavelengths absorbed by a gas, in this case, hydrogen.



According to the gas light passes through, different absorption lines will appear. Different absorption lines will appear based on the gas the light passes through. Since the absorption lines (fingerprint) for each chemical element has been discovered, these fingerprints are used by astronomers to identify the elements that are in a star. In the image below, you will see the absorption lines for different chemical elements, including hydrogen, helium, lithium, and sodium. Using these fingerprints, identify the elements that are in the Sun and Star DR85

Absorption lines for comparison



Absorption lines of stars



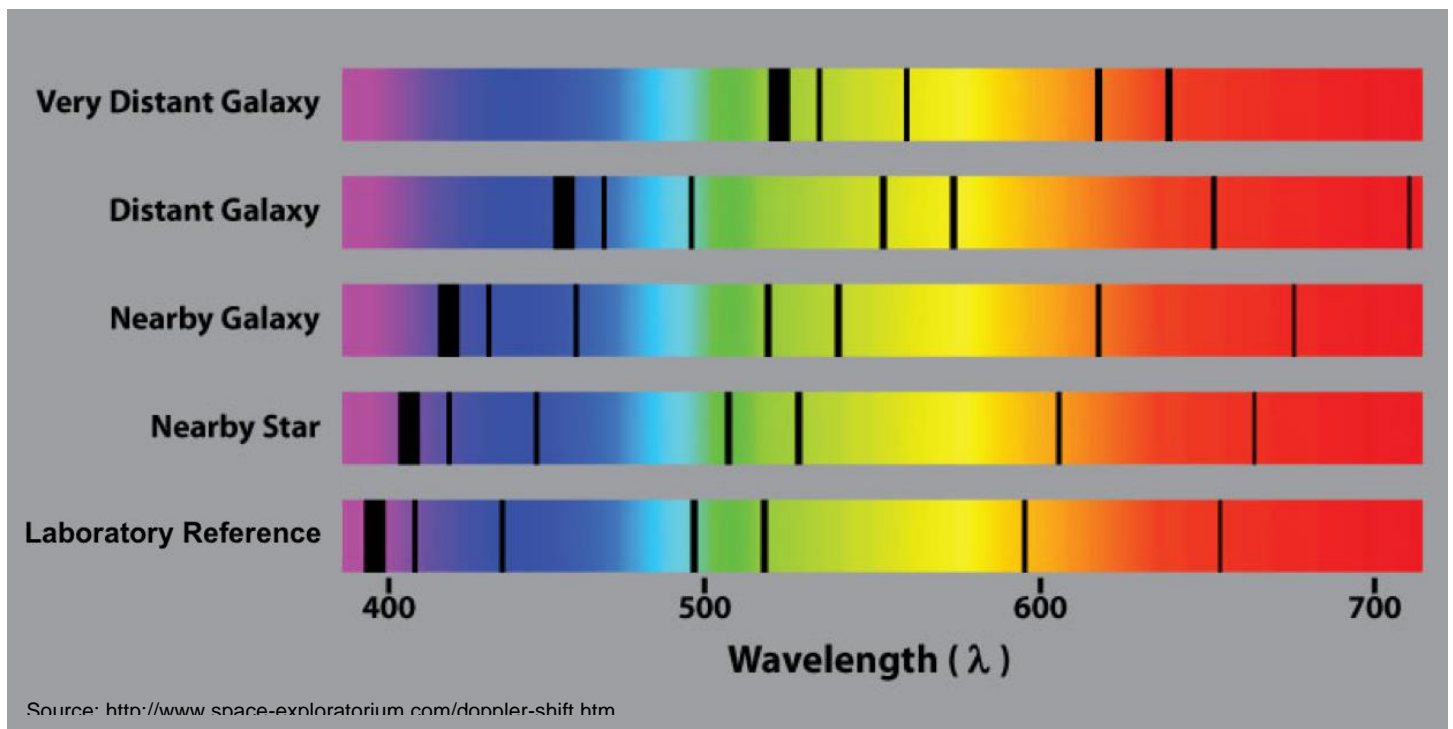
Elements present in the Sun:

Elements present in the Star DR85:

Read - Read the text about Hubble and examine his evidence for the whether the universe is changing or not.

Universe: Static, Contracting, or Expanding?

In 1929 Astronomer Edwin Hubble investigated the absorption lines of different galaxies and stars in order to determine whether Galaxies and other objects in the universe were moving away from or closer to our own galaxy. As you remember, as a result of the Doppler effect, if galaxies were moving away from us, the wavelengths would become (hint: shorter or longer?) _____. If this was the case, then the absorption lines would move toward the _____ color (hint: red or blue?). He compared these results with a laboratory reference. The image below represents the results that Mr. Hubble found:



Why do you think he used a Laboratory reference?

C.E.R - Make a claim about whether the universe is static, contracting, or expanding based on the evidence provided.

Using the evidence that Hubble found, would you claim that the universe is expanding, contracting, or static?

1. What is your claim (conclusion):

2. What relevant evidence supports your claim?:

In order to make stronger and more convincing claims, scientists connect the evidence and the claim using scientific ideas that explain why and how the evidence supports the claim. Thus, use your understandings about the doppler effect and waves to explain why the evidence supports your claim you made about the universe: