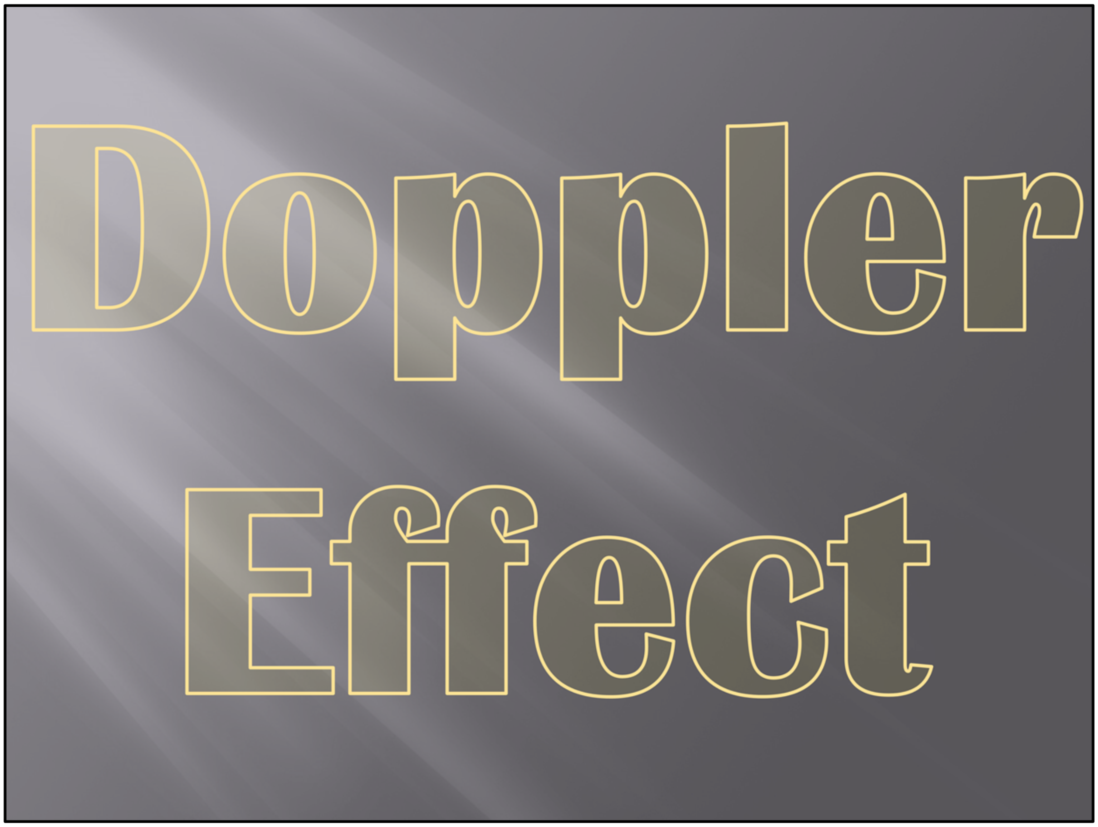
Module 4: Radiation and the Electromagnetic Spectrum
Topic 4 Content: Doppler Effect Presentation Notes



The Doppler Effect

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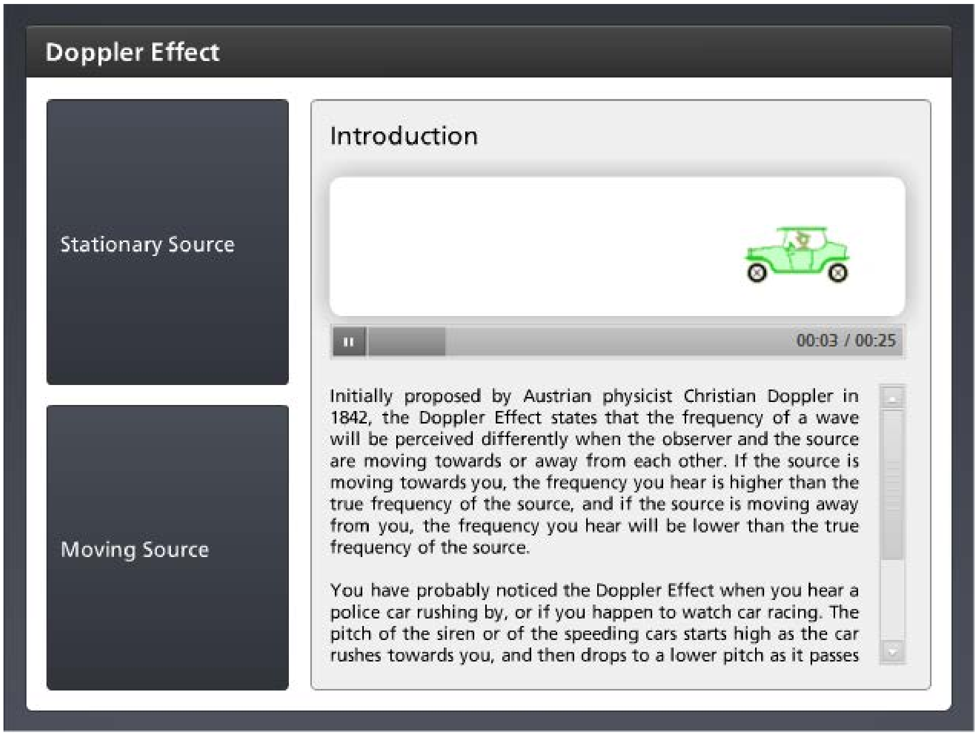

Initially proposed by Austrian physicist Christian Doppler in 1842, the Doppler Effect states that the frequency of a wave will be perceived differently when the observer and the source are moving towards or away from each other. If the source is moving towards you, the frequency you hear is higher than the true frequency of the source, and if the source is moving away from you, the frequency you hear will be lower than the true frequency of the source.

You have probably noticed the Doppler Effect when you hear a police car rushing by, or if you happen to watch car racing. The pitch of the siren or of the speeding cars starts high as the car rushes towards you, and then drops to a lower pitch as it passes and zooms away from you.

Click on the tabs to learn more about the Doppler Effect in relation to stationary and moving sources of sound.

Tab 1: If the source of sound is stationary, the sound that it makes radiates out equally in all directions, producing a set of concentric circles of sound.

Tab 2: If the source is in motion, the waves in front of the source are compressed and the waves in back of the source are further apart. So, if the source is coming toward you, the crests are closer together and you hear a higher frequency. If the source is moving away from you, the crests are farther apart and you hear a lower frequency.

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One of the wave phenomena for sound is the Doppler Effect. If light is a wave, then it too should experience a similar phenomenon.

Remember that each element has a distinct atomic spectrum due to its specific electron energy levels.

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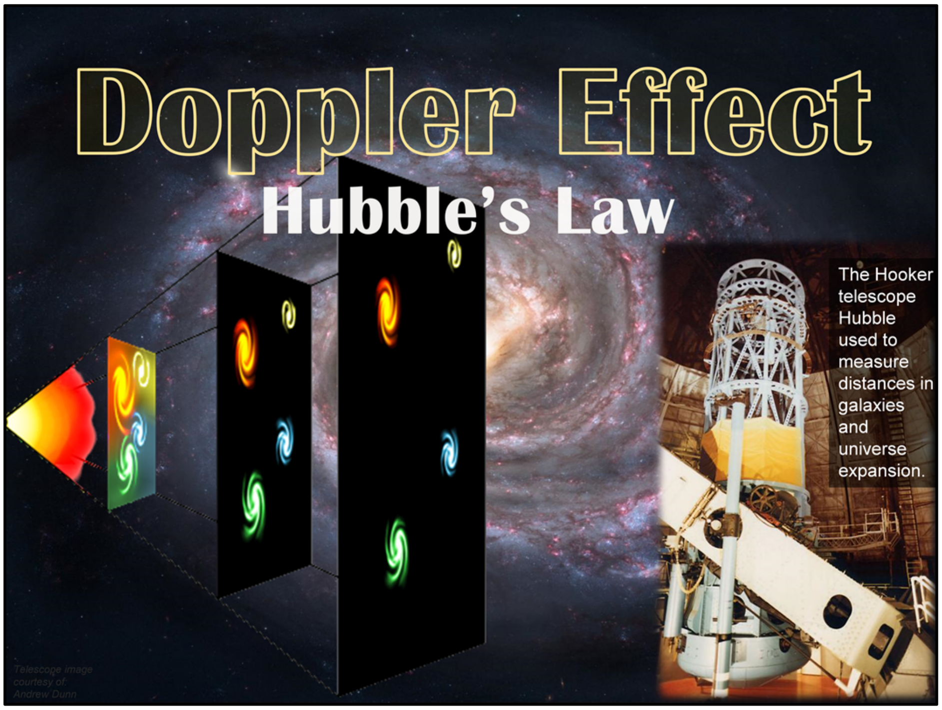
When scientists look at distant stars, they recognize the spectra of elements, such as hydrogen and helium, commonly found in stars. However, if the star is moving relative to Earth, the wavelengths of each of these spectral lines are shifted compared to their known values. If a star is moving towards Earth, then the perceived frequencies of the light waves are higher than expected and the wavelengths would be shorter, or “blueshifted.” If a star is moving away from Earth, then all the perceived frequencies of the light waves are lower than expected and would seem to be stretched out to longer wavelengths, or “redshifted.” This shift explains the differences in the spectra that scientists observe, and is another example of the wave nature of light.



American astronomer, Edwin Hubble was the first to confirm galaxies beyond the Milky Way. He combined information about the distance of galaxies and the shifts in their spectra to determine a direct relationship between how far a galaxy is from Earth and how quickly it is moving away from Earth. This relationship, known as Hubble's Law, helped determine that the universe is expanding.

Hubble's Law has been used to calculate that, at some point between thirteen and fifteen billion years ago, all the distant galaxies would have been at the same position in space, one of the first pieces of evidence supporting the Big Bang Theory.