

# Pre-Lab

## The Expansion of the Universe

In the 1920s Hubble and Humanson obtained many pictures of pretty galaxies. He paid particular attention to Cepheid Variables. These stars pulsate in a characteristic fashion, which depends on their Absolute Magnitude. Since the apparent magnitude of those stars can be measured directly, the difference between absolute and apparent magnitude provides a method of determining the distances to these stars. At the same time Hubble also obtained spectra of the same galaxies, and from the positions of the absorption lines of those galaxies, he was able to determine the recessional velocity of the galaxies in his sample. In this exercise you will follow in Hubble's steps, and determine the velocities of galaxies in a similar manner. More specifically, you will measure the redshift. Following that you will correlate the distance of each galaxy to its recessional velocity, and you will discover yourself that the universe is indeed expanding. Puhhh, what a discovery!

You will also use the concept of redshift which is illustrated below. For sound waves, if an object is approaching its wavelengths are crunched together resulting in a high pitch. If the object is receding the wavelengths are stretched resulting in a lower pitch. The same phenomenon is valid for light. Approaching objects have a higher frequency or shorter wavelength while receding objects show a lower frequency and longer wavelengths. Since shorter wavelengths mean bluer colors and longer wavelengths redder colors, we will observe a bluehift of approaching objects and a redshift for receding objects.

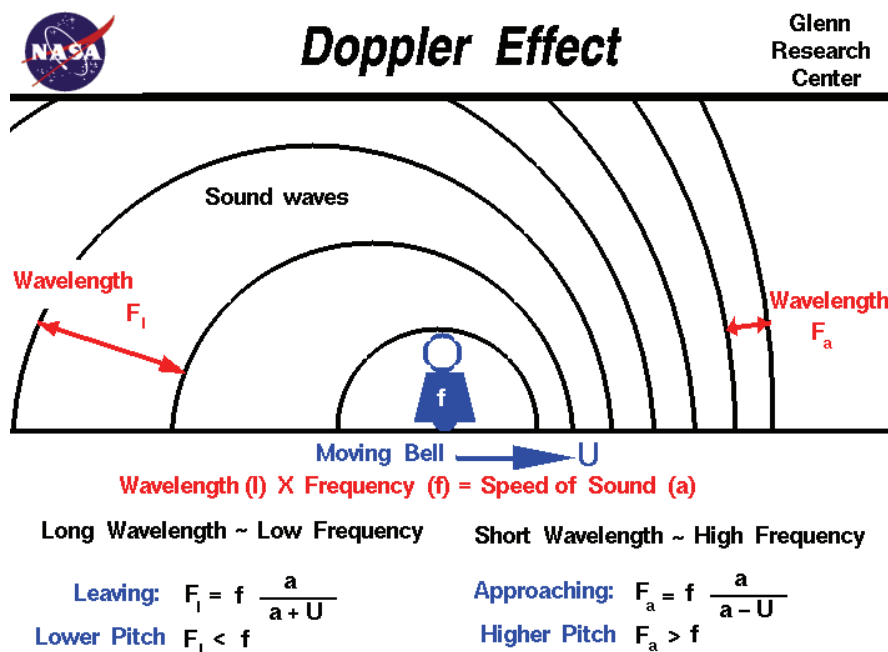


Image taken from <http://www.grc.nasa.gov/WWW/K-12/airplane/doppler.html>.

# Pre-Lab

1) Explain the meaning of Hubble's Law (Use your OWN words; do NOT copy anything from the book).

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2) In your OWN words define the following quantities (and do NOT copy anything from the book).

a) Doppler Shift

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b) Blueshift and Redshift

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3) Then explain the DIFFERENCES between the different types of Redshifts

a) Doppler-Redshift

b) Gravitational Redshift

c) Cosmological Redshift

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4) The rotation curves of galaxies are determined by measuring the "shift" of certain spectral lines. What type of redshift are we dealing with in this example? Explain.

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