The Doppler Effect

When a car passes you while you are standing on the side of a road you hear the sound of the engine or a horn change frequency.

Coming towards you it sounds like eeeeee and oooooo when it is passes you.

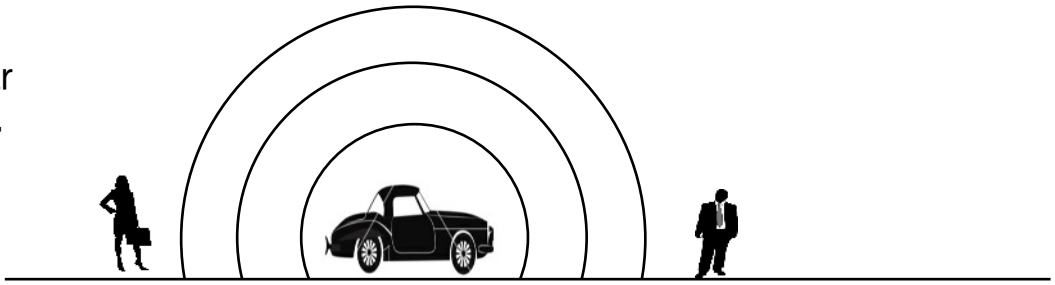
This change of frequency is called the Doppler effect named after Austrian physicist Christian Doppler. He discovered this phenomena in 1842.

http://goo.gl/8JNqzT

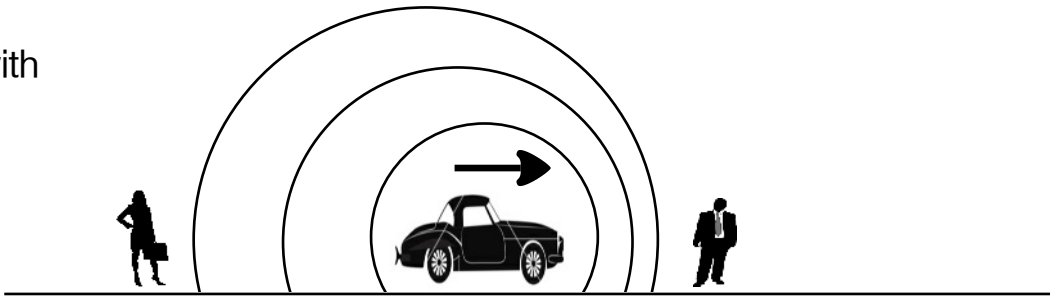
Doppler explained

The Doppler effect is the change in frequency observed when a source of sound is either moving away or towards an observer.

Stationary car sounds horn.



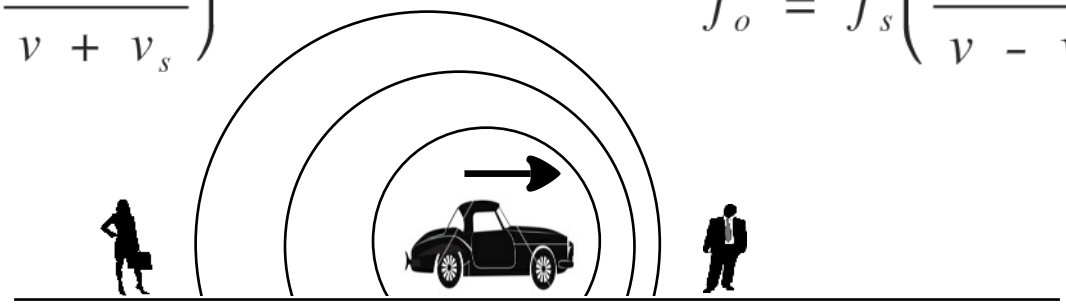
Car moving with speed v_s



Car moving with speed v_s

$$f_o = f_s\left(\frac{v}{v + v_s}\right)$$

$$f_o = f_s\left(\frac{v}{v - v_s}\right)$$



Example 1

A fire engine's horn emits a frequency of 850 Hz.

It is travelling at 30 m s^{-1}

Calculate the frequency of sound an observer hears as it approaches him.

Calculate the frequency of sound the observer hears as the fire engine travels away from him.

Applications of the Doppler effect.

Most applications of the Doppler effect are applied to finding the velocity of objects.

This involves transmitting waves towards a moving object and picking up the reflected waves.

The reflected waves have a change of frequency directly proportional to the velocity of the target

The equation for the frequency change has to be worked out and is not part of this course.

But to give an idea how the applications work here is the equation used.

$$\triangle f = \frac{2vf}{c}$$

V = velocity of the object

F = frequency of transmitted wave

C = speed of transmitted wave

Δf = difference between transmitted and reflected waves

If the waves are transmitted at an angle of Θ to the movement of the object , then the above equation is adapted to:

$$\triangle f = \frac{2fv\cos\theta}{c}$$

Applications of the Doppler effect.

Go to the slide notes to get a fuller description of the applications.

Use the QR code to get the info.

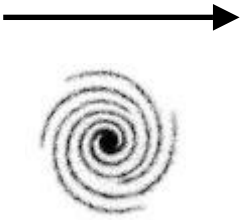
Police Speed cameras

Windshear Detection

Speed of blood in veins or arteries

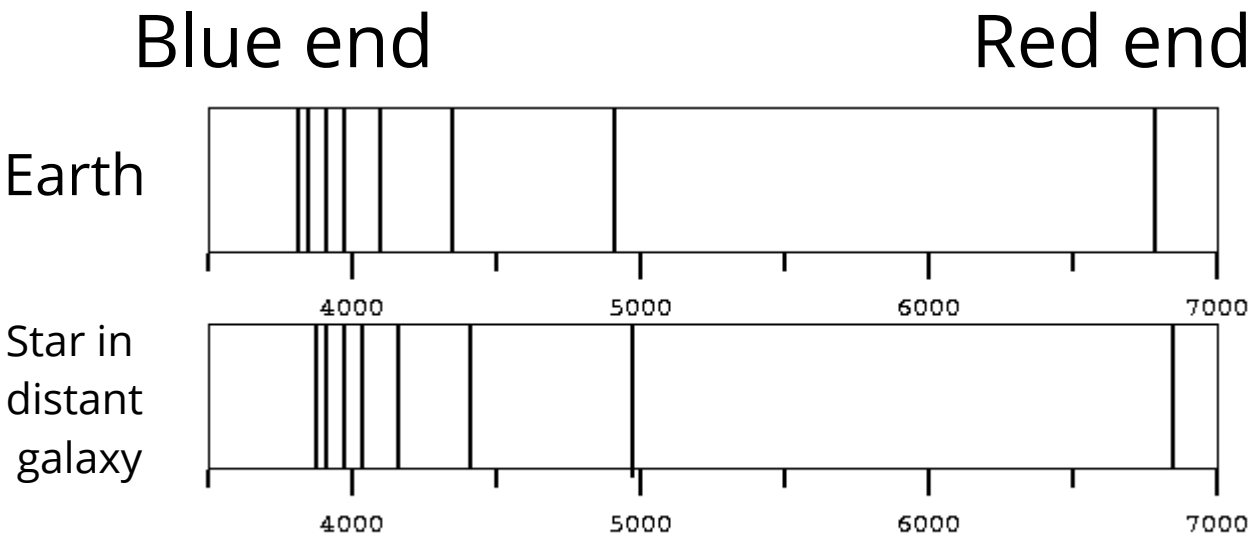
Doppler Effect explains Redshift

When the spectra of stars from a distant galaxy are compared to the spectra of the elements on Earth the spectral lines are shifted towards the _____ end of the spectrum.

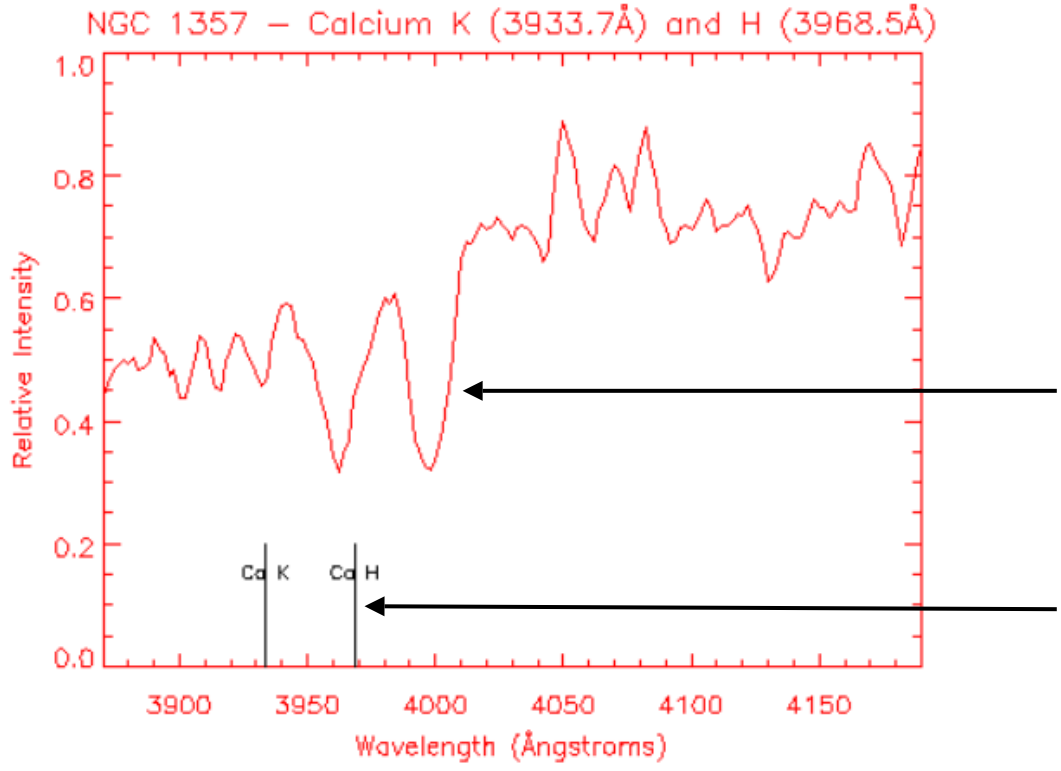


This means the observed wavelength of the stars has _____

This means that the stars in the galaxy must be moving away from the Earth.



x 10^{-10} metre

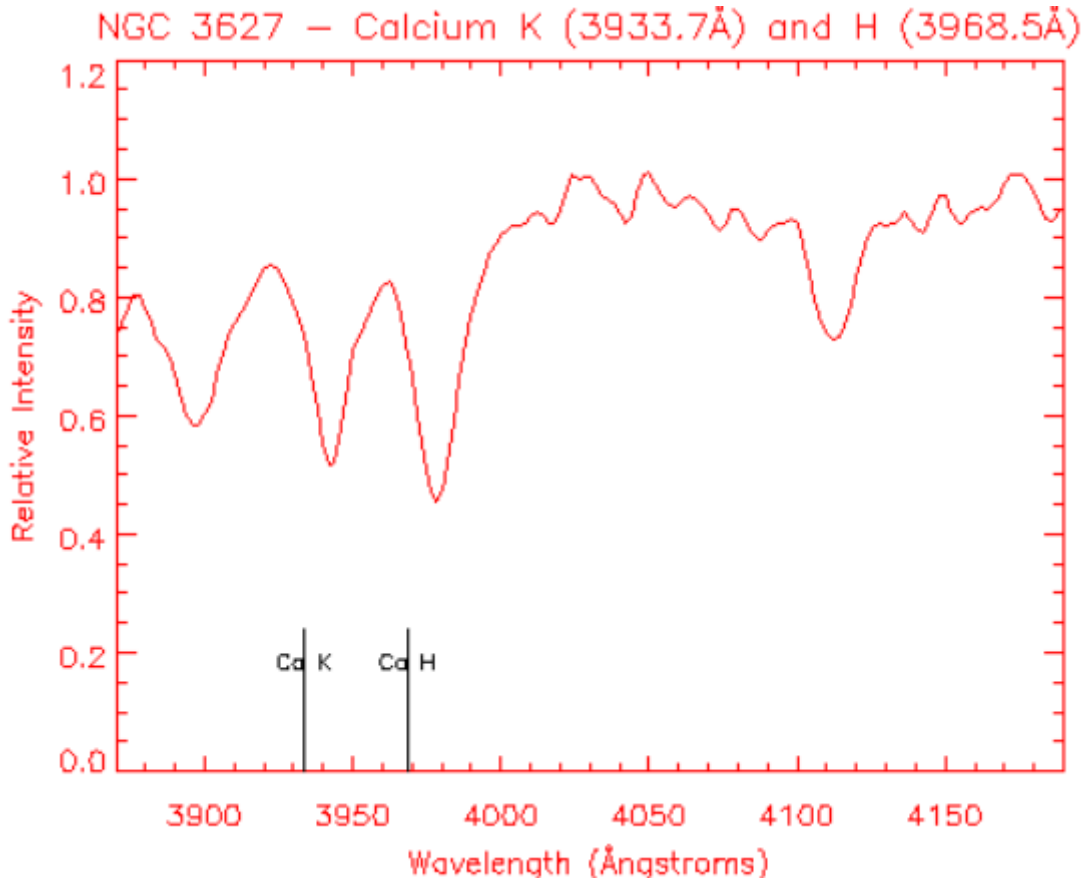


Redshift can be used to find the speed that galaxies are moving away

The redshift is defined as

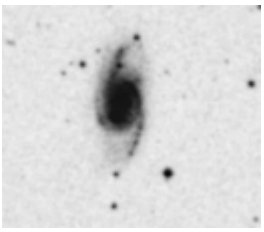
$$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$$

Example Find the redshift in one of the stars in the galaxy NGC 3627

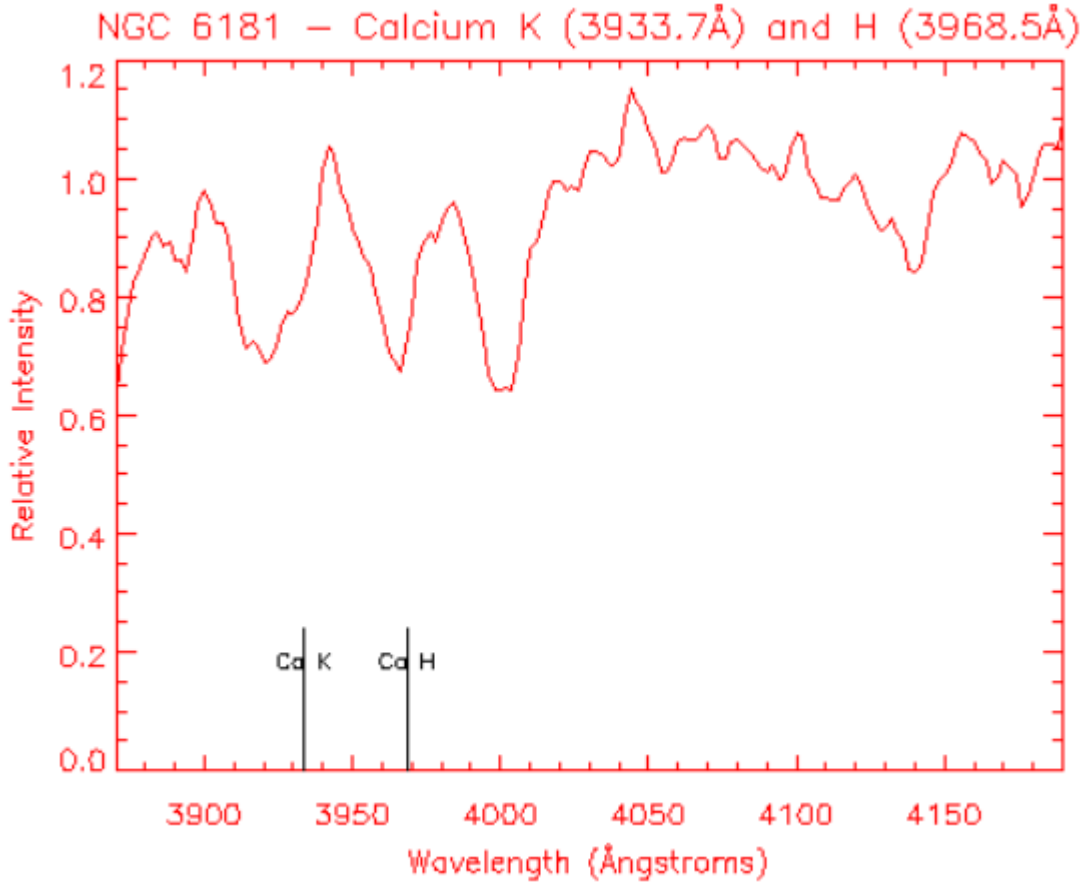


Example

Astrophysicists observe the galaxy as shown.



The absorption lines of Calcium K and calcium H are identified on the spectra.



Galaxy`s Catalogue Name .....

Wavelength of the Ca H line as measured in the lab .....

Wavelength of the Ca H line observed in the galaxy .....

$$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}}$$

Redshift value z =

Redshift value and the speed of the galaxy

The redshift value z can be written as

$$z = \frac{v}{c}$$

Knowing the redshift of the galaxy we can find the speed it is moving away from us!

Galaxy	Redshift z	V
v NGC 3627		

Galaxy	Redshift z	V
NGC 6181		

Redshift value and the speed of the galaxy

$$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}} \qquad z = \frac{v}{c}$$