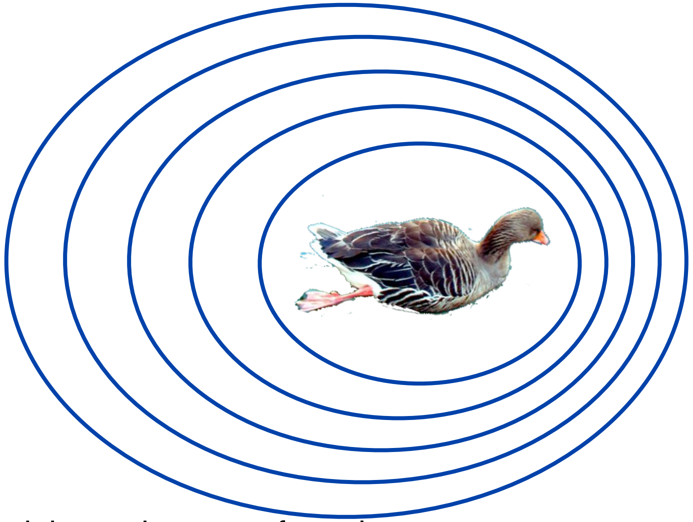
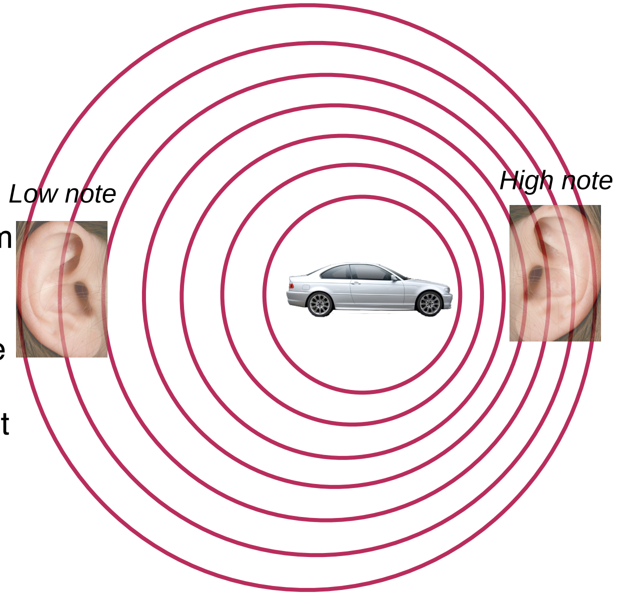
The Doppler Effect
The Fizzics Organisation

A duck will make a circular pattern of waves as it sits on the pond.



1 When it swims it is moving away from the waves behind and towards the waves in front. The waves in front are bunched up, the wavelength is shorter.

2 In the same way the noise from a stationary car will spread out symmetrically in all directions. If the car is driven fast then the sound waves behind are stretched out and those in front are bunched up. If you listen to a fast car going past you then the note changes. It is higher as it approaches and slightly lower when it has passed.



This diagram is exaggerated. The car would have to be traveling very fast for the sound waves to bunch up this much.

3 Early last century astronomers examining light from distant galaxies noticed that in most cases the patterns were shifted into the red end of the spectrum.

The characteristic lines of *absorption spectra* stayed in the same pattern but were shifted into different colours.

They concluded that the longer wavelengths meant that these galaxies are moving away from us. They have to be moving very fast to cause this change to light waves which travel at 3×10^8 ms^{-1}

Light from our own sun or stars in our own galaxy

Light from distant galaxies. The black lines are moved towards the red colours.

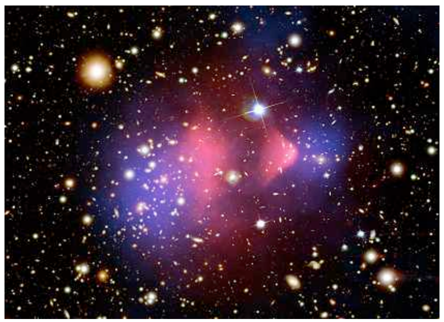
4 The faster things move as a proportion of the wave speed, the bigger the change in wavelength and frequency.

If the speed of the source is only a small fraction of the speed of the waves then the connection is like this:

$$\frac{\text{Change in frequency}}{\text{Original frequency}} = \frac{\text{speed of object}}{\text{speed of the waves}}$$

or

$$\frac{\text{Change in wavelength}}{\text{Original wavelength}} = \frac{\text{speed of object}}{\text{speed of the waves}}$$



The further away the galaxies the greater the "red shift". This is evidence in favour of the "big bang theory".