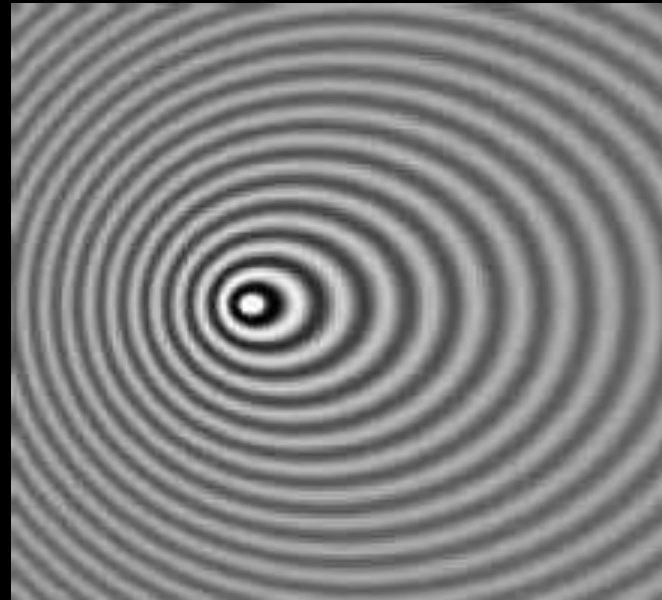


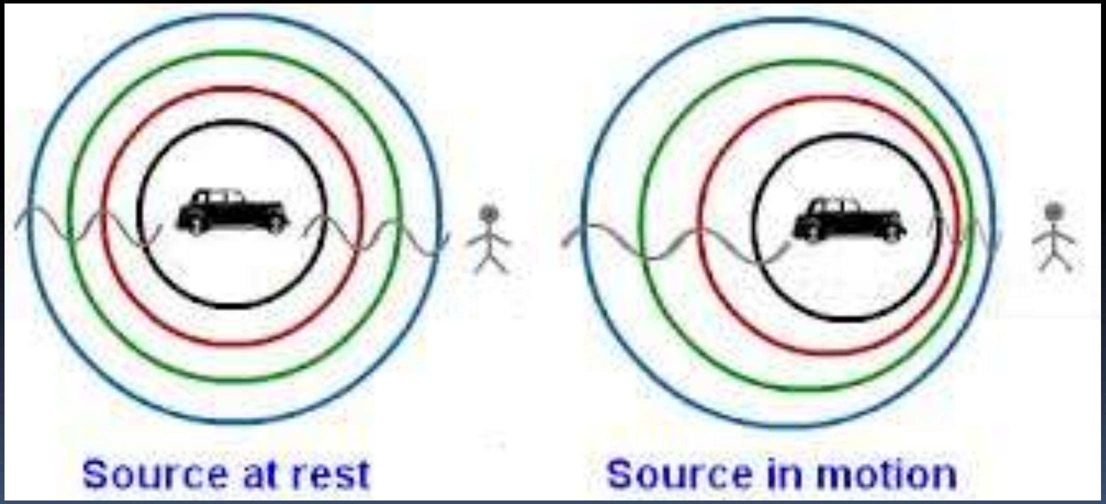

The
Doppler Effect

In 1842 in Prague, the Austrian physicist Christian Doppler proposed that the change in frequency of a wave for an observer is relative to the motions of its source.

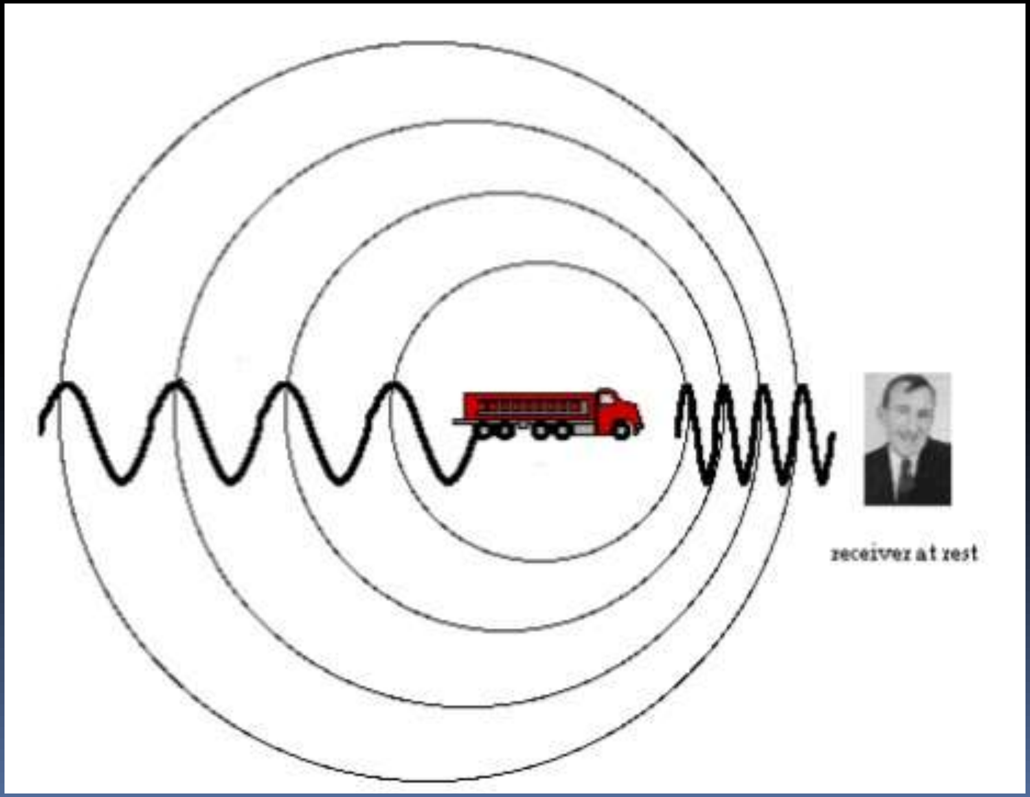
- According to this relativity,

- The received frequency is
- higher while it is being nearer,
- identical at the instant of passing by,
- lower during the recession.

- The relative changes in frequency can be explained as follows. When the source of the waves is moving toward the observer, each successive wave crest is emitted from a position closer to the observer than the previous wave.

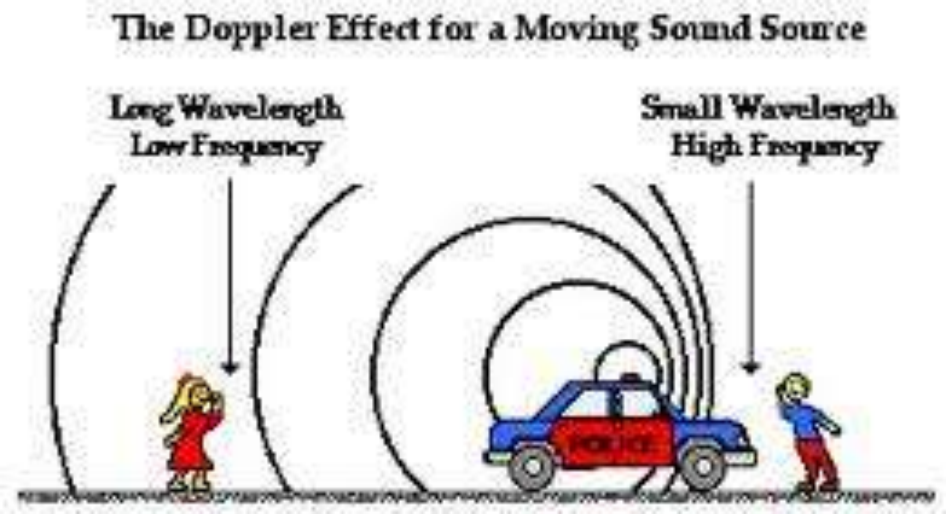


- Therefore each wave takes slightly less time to reach the observer than the previous wave. Therefore the time between the arrival of successive wave crests at the observer is reduced, causing an increase in the frequency



- While they are travelling, the distance between successive wave fronts is reduced; so the waves "bunch together".

- Conversely, if the source of waves is moving away from the observer, each wave is emitted from a position farther from the observer than the previous wave, so the arrival time between successive waves is increased, reducing the frequency. The distance between successive wave fronts is increased, so the waves "spread out".



- For waves that propagate in a medium, such as sound waves, the velocity of the observer and of the source are relative to the medium in which the waves are transmitted.

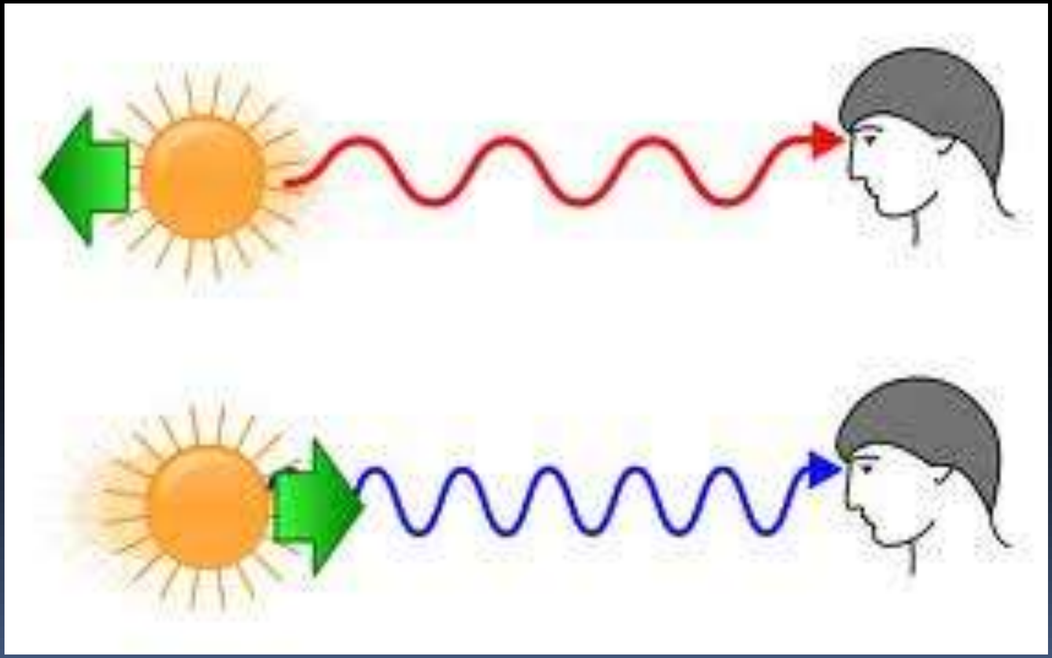
- The total Doppler effect may therefore result from 3 facts:
- -motion of the source,
- -motion of the observer,
- - motion of the medium.

Development:

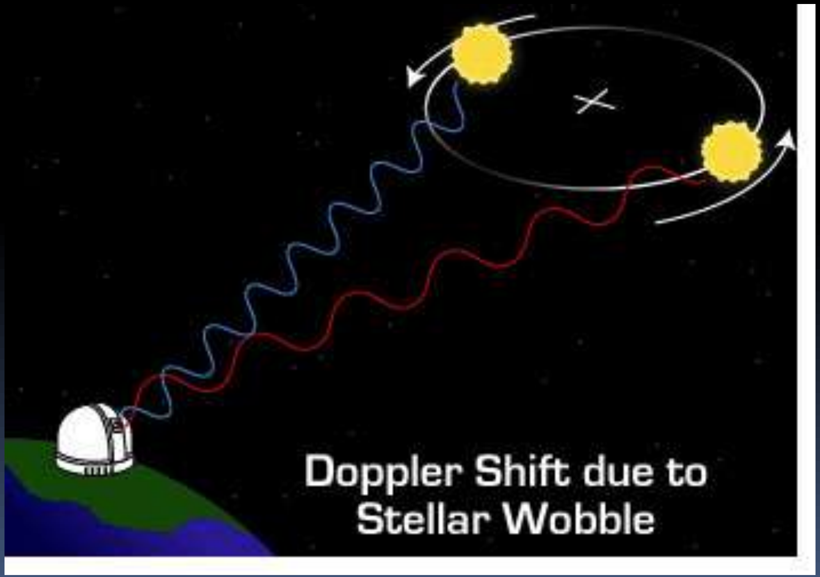
- the Austrian physicist Christian Doppler, who proposed it in 1842 in Prague
- The hypothesis was tested for sound waves by Buys Ballot in 1845
- In 1848,Hippolyte Fizeau discovered independently the same phenomenon on electromagnetic waves in 1848 in France, the effect is sometimes called "l'effet Doppler-Fizeau".
- In Britain, John Scott Russell made an experimental study of the Doppler effect (1848).

Astronomy

- Doppler effect for electromagnetic waves such as light is of great use in astronomy.
- It results in either redshift or blueshift.



- It has been used to measure the speed at which stars and galaxies are approaching or receding from us, that is, the radial velocity.

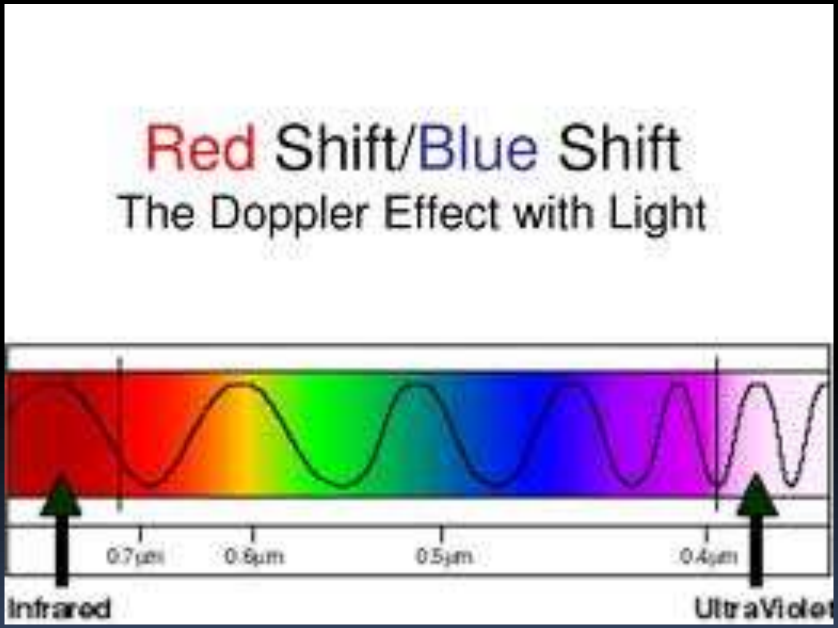


This is used to detect if an apparently single star is, in reality, a close binary and even to measure the rotational speed of stars and galaxies.

- The use of the Doppler effect for light in astronomy depends on our knowledge that the spectra of stars are not continuous.

- They exhibit absorption lines at well defined frequencies that are correlated with the energies required to excite electrons in various elements from one level to another.

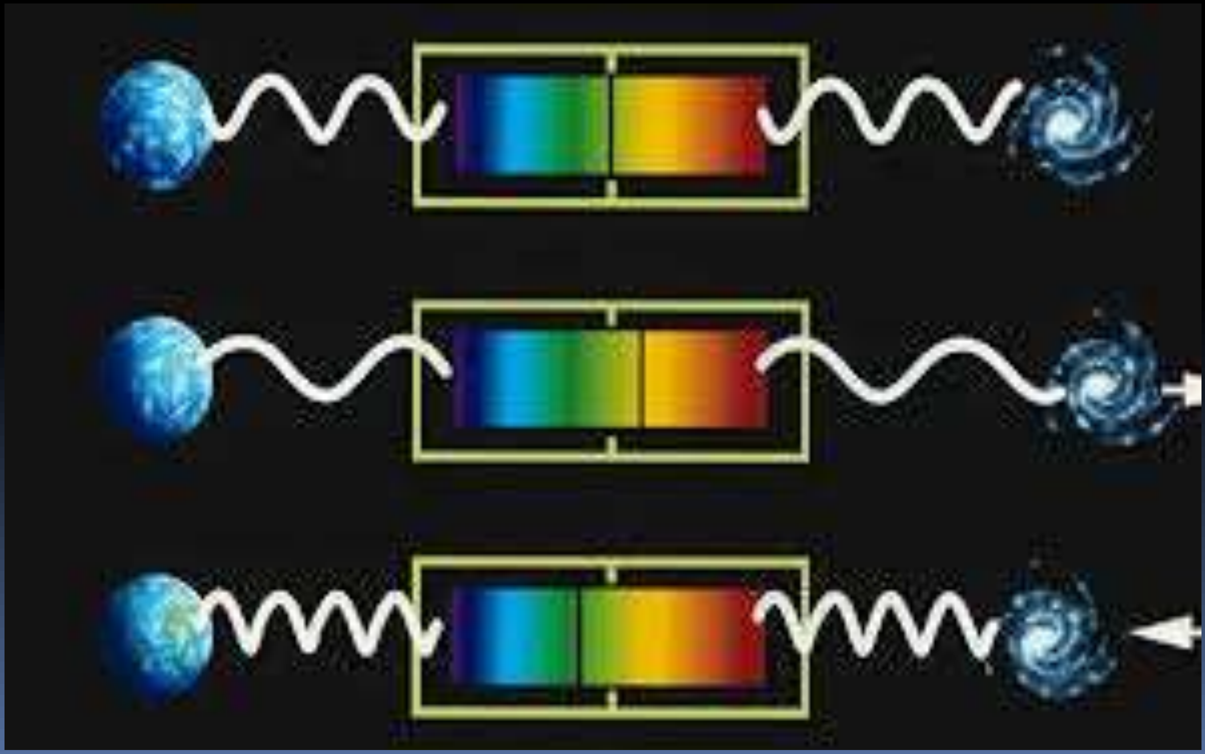
- The Doppler effect is recognizable in the fact that the absorption lines are not always at the frequencies that are obtained from the spectrum of a stationary light source.



Since blue light has a higher frequency than red light, the spectral lines of an approaching astronomical light source exhibit a blueshift and those of a receding astronomical light source exhibit a redshift.

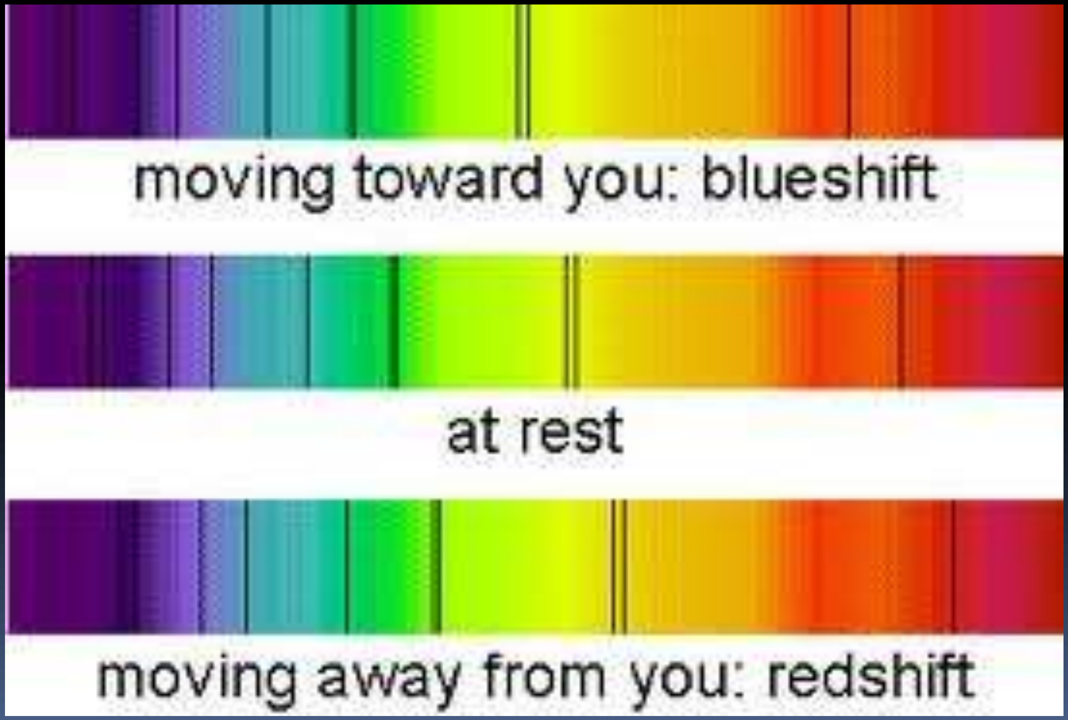
Temperature Measurement

- Another use of the Doppler effect, which is found mostly in plasma physics and astronomy, is the estimation of the temperature of a gas which is emitting a spectral line.



- Due to the thermal motion of the emitters, the light emitted by each particle can be slightly red- or blue-shifted, and the net effect is a broadening of the line.

This line shape is called a Doppler profile.



The width of the line is proportional to the square root of the temperature of the emitting species.

It allows a spectral line to be used to infer the temperature.

- ^ Effects of Red Shifts on the Distribution of Nebulae, Hubble, Edwin, Astrophysical Journal, vol. 84, p.517, The SAO/NASA Astrophysics Data System
- ^ Red-shifts and the distribution of nebul&aelig, Hubble, Edwin, Monthly Notices of the Royal Astronomical Society, Vol. 97, p.513, The SAO/NASA