

What is Light?

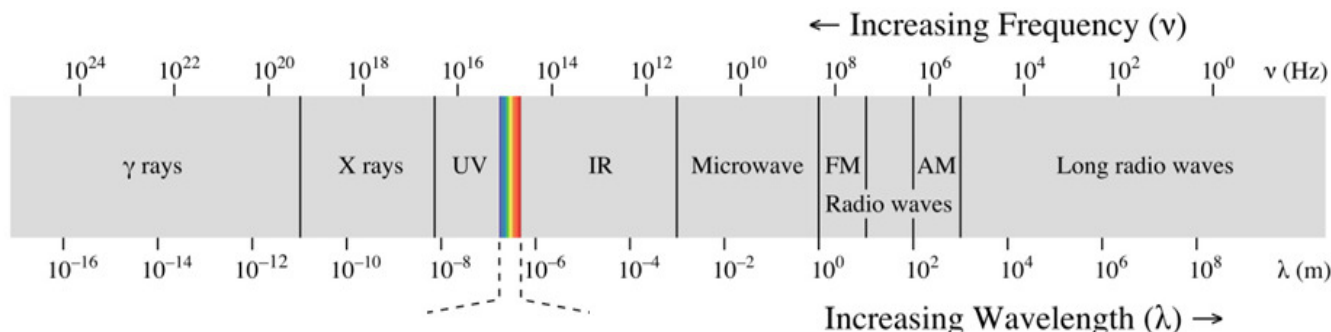
- 1) **The Nature of Light**
- 2) **The Electro-magnetic Spectrum**
- 3) **The “Birth” of Light**
- 4) **What can Light tell us about the Cosmos**

The nature of light - A short History

- In the beginning: Genesis 1:3 – *Then God said “Let there be light” and light appeared.* Happened on day 1 but actual date uncertain. Nature of light unexplained.
- Democritus of Abdera, circa 400 BC, argued the emission idea of vision, ie that objects cast off an image which was then impressed in the surrounding air.
- Plato & Aristotle, 300-400BC, refined this to a 2 way process, where the image was formed by the object but there was a radiation from the eye which gave these “husks” substance.
- Euclid, 300BC, introduced the concept of a light ray - emanating from the eye though.
- Hero of Alexandria, 100AD, light rays travelled in straight lines via the shortest route.
- Alhazen, 1000, following dissection of eyes, argued that the eye was a receptor, not a transmitter.
- Bacon, 1267, predicted the invention of devices to see small and far, ie microscopes and telescopes.
- Galileo, 1638, tried to estimate the speed of light but failed.
- Newton, 1672, showed that light was made of coloured particles with his prism experiment.
- Huygens, 1690, proposed the wave theory of light, which became the accepted idea.
- Young, 1807, provided proof that light was a wave, Young’s or the double slit experiment.
- Maxwell, 1831-1879, predicted the existence of electromagnetic waves travelling at the speed of light.
- Einstein, 1905, showed that light is particulate, comprised of photons.

We now understand that visible light is part of the EM spectrum and can behave as both a wave and a particle, or something in between. It travels at a fixed speed, in vacuum, 186,000 miles/sec. It travels in a straight line in space-time.

The Electromagnetic Spectrum



The higher the frequency (shorter wavelengths) the greater the energy of the individual photons. The energies vary from 10^{-14} eV at the radio end of the spectrum to 10^{12} eV at the gamma ray end. A range of 10^{26} . (That’s 1 to 100,000,000,000,000,000,000,000,000)

The Birth of Light

The Cosmic Microwave Background:- 380,000 years after the Big Bang when the gas became neutral and the Universe transparent. Before that time, when the gas was ionised and hot the Universe was opaque (to photons).

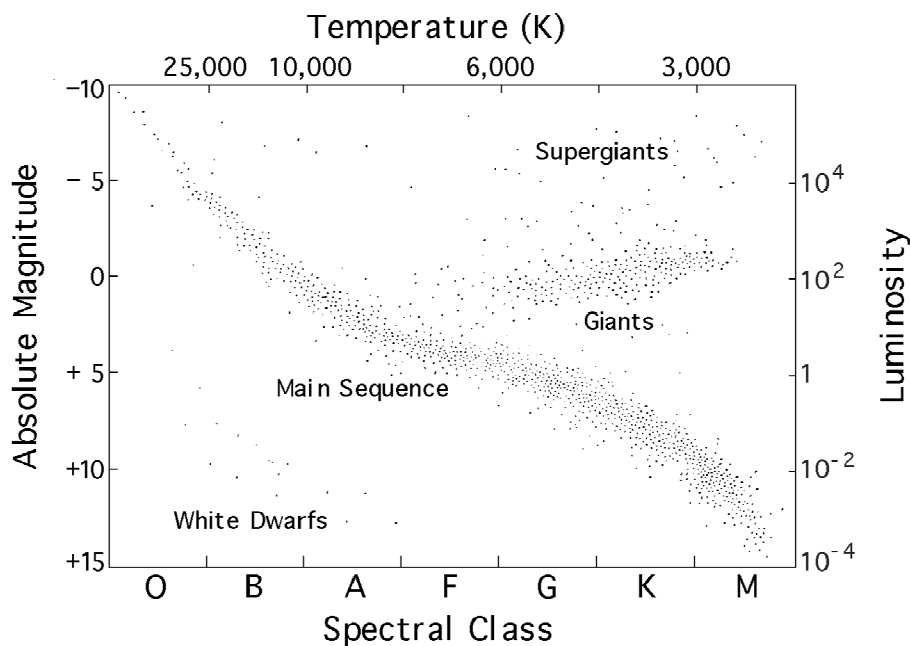
After 13.8 Billion years the CMB has cooled to around -270°C .

What can Light tell us about the cosmos - (almost) Everything we know

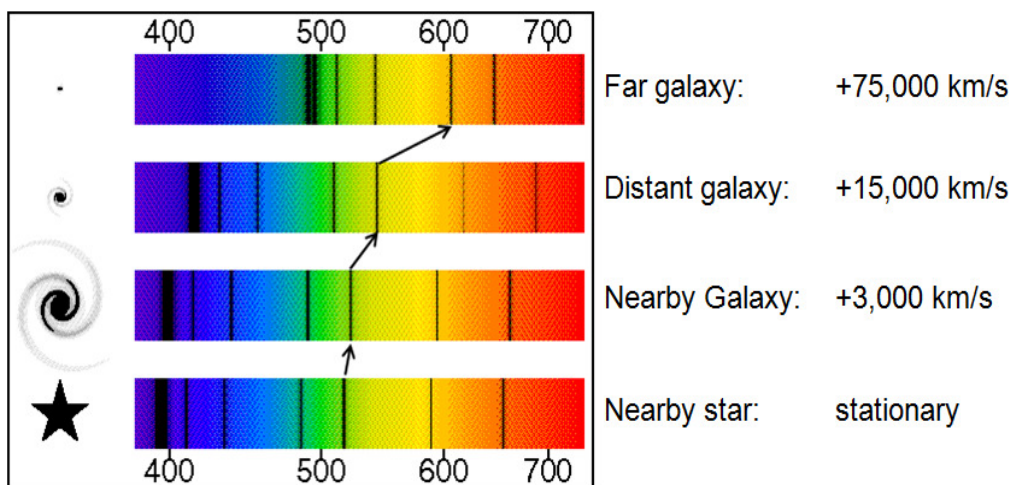
Telescopes at different frequencies show different aspects of the sky, Paul Roche, a couple of weeks ago, showed us how x-ray, visible and infra-red telescopes give complementary views of the same objects.

Use spectra to determine temp and composition of stars/galaxies, also the atmosphere of exo-planets.

Workout the life cycle of stars, Hertzsprung-Russell diagram



Determine the distance and speed, relative to us, of objects from their red shift.



SPECTRA AND RED SHIFT

Calculate the Hubble Constant to estimate the expansion rate of the Universe.