**Dynamics & Space**

**Cosmology**

**Summary**

The **Universe** consists of many galaxies separated by empty space.

A **galaxy** is a large cluster of stars (e.g. the Milky Way).

A **star** is a large ball of matter that is undergoing nuclear fusion and emitting light. The Sun is a star (as are Sirius, Rigel and Proxima Centauri).

A **planet** is a large ball of matter (rounded by its own gravity) that orbits a star (e.g. Earth or Jupiter). Planets do not emit light themselves.

The Sun and many other stars have a **solar system**. A solar system consists of a central star orbited by planets. Planets orbiting stars other than the Sun are known as **exoplanets**.

Many planets have moons. A **moon** is a lump of matter that orbits a planet (e.g. the Moon orbits the Earth and Deimos and Phobos orbit Mars).

The Universe is thought to have begun in an event, known as the **Big Bang**, around 13·8 billion years ago when all matter, and even space and time itself, came into existence. The universe began at a single point in space-time, known as a singularity; since then the universe has expanded and (according to observations) will continue to expand.

Distances in space are so enormous that we use units known as light-years to measure them. A **light-year** (ly) is the distance travelled by light in one year (around 9·5 × 1015 m).

For example: Proxima Centauri (the nearest star, apart from the Sun) is 4·3 light-years away; our galaxy (the Milky Way) is around 100 000 light-years across and the next nearest spiral galaxy (Andromeda) is 2·5 million light-years away.

Our current understanding of the Universe comes from observations of it using **telescopes**.



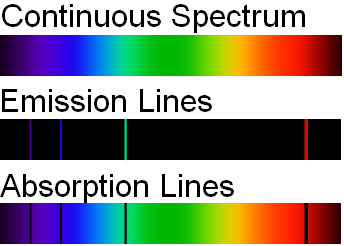
Today we use telescopes which cover all parts of the **electromagnetic spectrum** to investigate astronomical objects:

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| --- | --- | --- |
| **Part of Spectrum** | **Examples of telescopes** | **Observations made** |
| **radio** | Arecibo  Joddrell Bank  Very Large Array (VLA) | * discovery of pulsars and quasars * studying plasma clouds * studying the Sun’s magnetic field |
| **microwaves** | Holmdel Horn Antenna  Cosmic Background Explorer (COBE) | * the existence of cosmic microwave background radiation – evidence of the Big Bang |
| **infrared** | Spitzer  Herschel | * studying nebulae, gas clouds and the formation of stars * identification of exoplanets |
| **visible light** | Hooker  Kepler  Very Large Telescope (VLT)  Hubble Space Telescope | * observations of galactic redshift – evidence of the expanding Universe * imaging planets, stars and galaxies |
| **ultraviolet** | Galaxy Evolution Explorer (GALEX) | * studying star formation * measurement of distances to distant galaxies |
| **X-rays** | Solar and Heliospheric Observatory (SOHO) Chandra | * studying the Sun’s atmosphere * studying supernovae |
| **gamma rays** | Fermi | * evidence of supermassive black holes at centres of galaxies * studying gamma ray bursts – probably due to hypernovae |

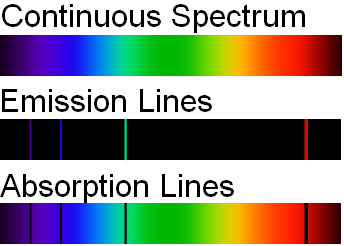
e.g.

One of the techniques used in astronomy is **spectroscopy**

A complete (continuous) spectrum is made up of all the colours of the spectrum (red, orange, yellow, green, blue, indigo and violet).



A line spectrum consists of a complete (continuous) spectrum with certain colours missing which appear as black line in the spectrum. Every element produces a unique line spectrum.



Studying line spectra allows the elements present in a light source (e.g. a star) to be identified. This can allow the type, distance, age or speed of a star to be identified.