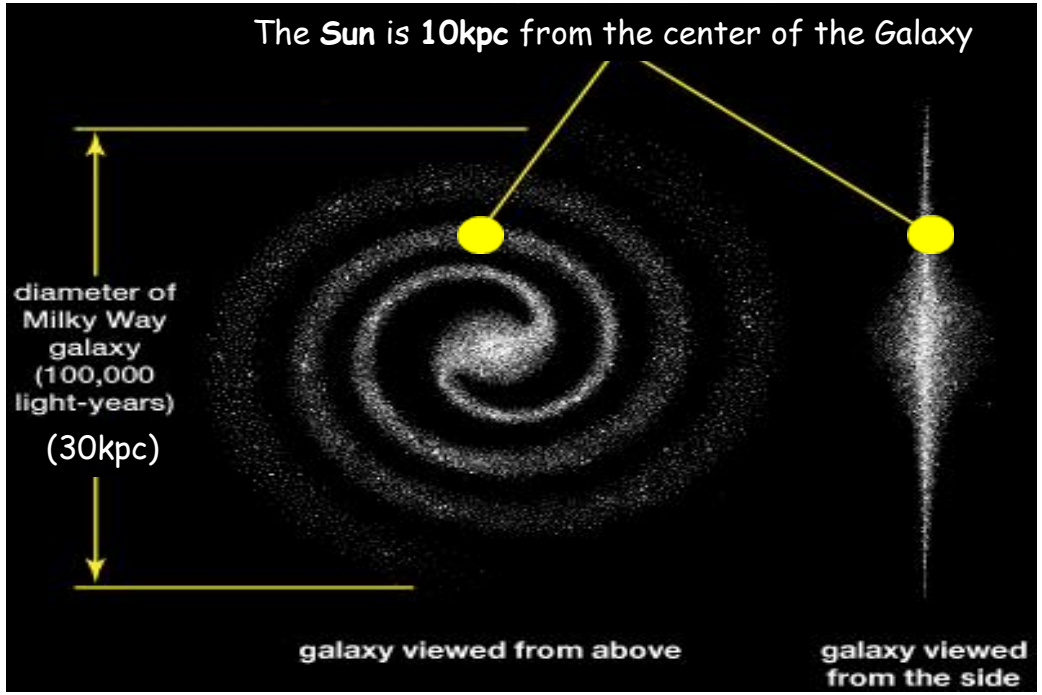
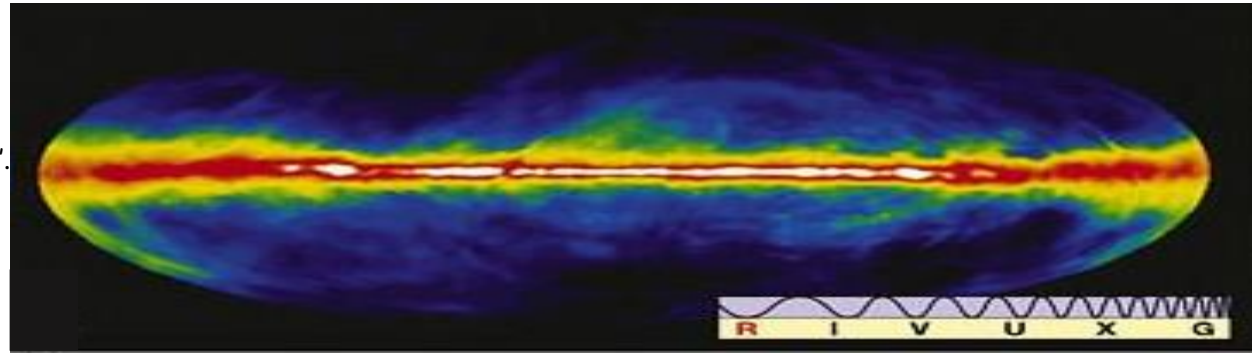
Astronomy **Summary Knowledge Organiser** – Ch. 15 (Topic 15) **Our place in the Galaxy (i) The Milky Way**

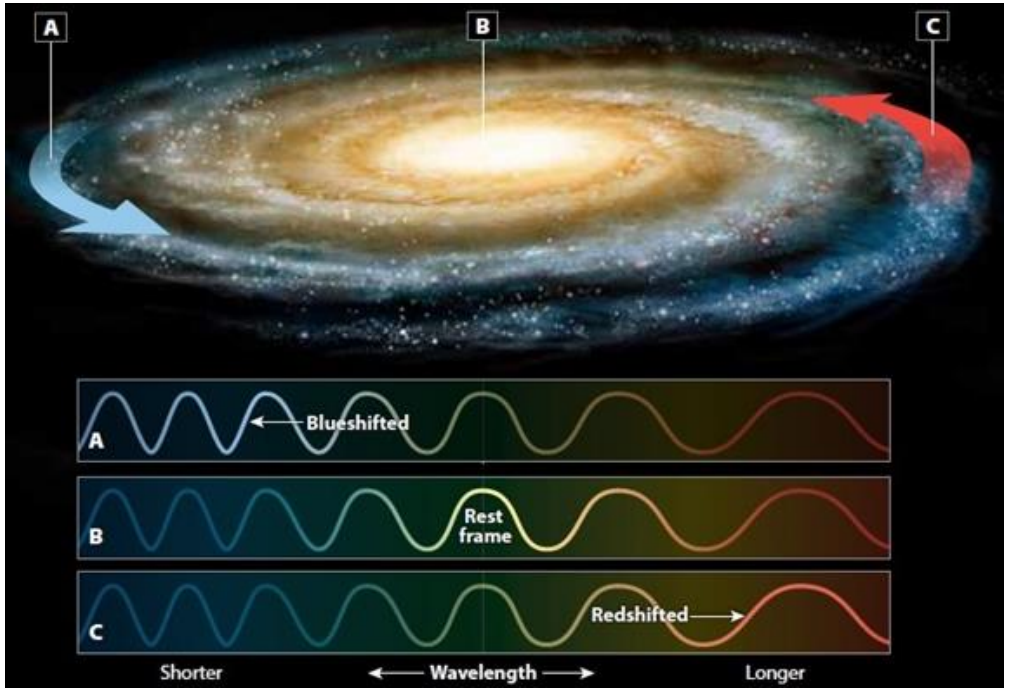
When **Galileo** first used his simple telescope he informed us that '**stars are not distributed uniformly throughout the Universe**'. He discovered that stars are grouped into **GRAVITATIONALLY-BOUND COLLECTIONS** called **galaxies**!
The galaxy we live within is called the **Milky Way** because when we look into the sky, **along its plane where most stars are located**, we see a '**faint patchy band of light**'.
If we could leave our Milky Way galaxy, move **above it** and then turn around to look at it, it would look like a 'giant disc-shaped Catherine wheel rotating around a central bulge (nucleus)'. From a **side view** it would look like 'two back-to-back fried eggs'.



The **SPIRAL ARMS** of the Galaxy are made of **gas and dust clouds** and so these are **STAR FORMING REGIONS**. These dusty arms do not allow visible light to pass through them and so it is difficult to study their **structure** and **motion**. To find out this information astronomers have instead studied them using the **21-cm radio waves** that hydrogen atoms in the spiral arms emit. Hydrogen atoms have a single electron orbiting a single proton and when the **electron reverses its direction of spin**, a small amount of **energy is emitted as a photon** of radiation with a wavelength of 21cm.



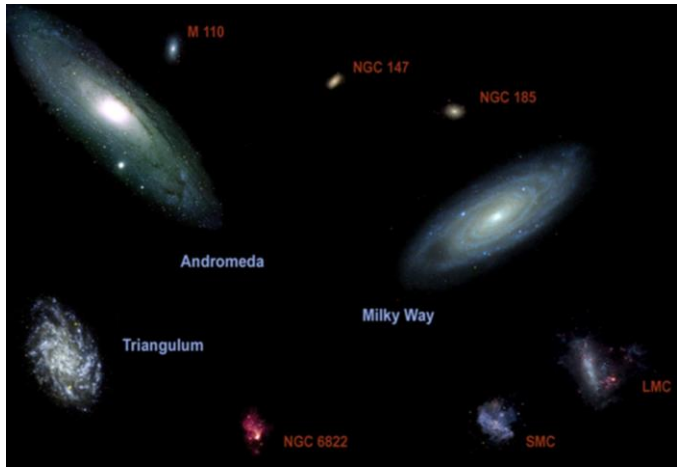
Above is a **21-cm radio image** looking into the plane of our Milky Way Galaxy.
To study **how the galaxy rotates** we measure how the **DOPPLER EFFECT** causes the wavelength of the 21-cm radio waves to change. If the radio waves we pick up from a gas cloud in the galaxy are **slightly longer than 21-cm** in wavelength, it tells us the cloud is **moving away from us** (relative to our line-of-sight).



The radio wave has been '**red-shifted**' and its **wavelength has been lengthened** due to the Doppler Effect. When studying clouds **moving towards us** we will pick up radio waves with a wavelength **slightly less than 21-cm (blue-shifted)**. A **larger 'Doppler-Shift'** means the **relative velocity** of the source, towards or away from the observer. is **faster**!

Summary Knowledge Organiser – Ch. 15 (Topic 15) **Our place in the Galaxy (i) Classes of galaxies & AGNs**

Galaxies are grouped together on a variety of scales. On the smallest scale our galaxy the Milky Way is a member of **THE LOCAL GROUP** that contains **about 50 galaxies** that are **held together by mutual gravitation**. The Local Group is **3 megaparsecs (Mpc) across**! Members of the Local Group include;
Andromeda Galaxy (M31)
Small & Large Magellanic Clouds (SMC & LMC) small irregular satellite galaxies
Triangulum Galaxy (M33)
Phoenix Dwarf & Aquarius Dwarf galaxies

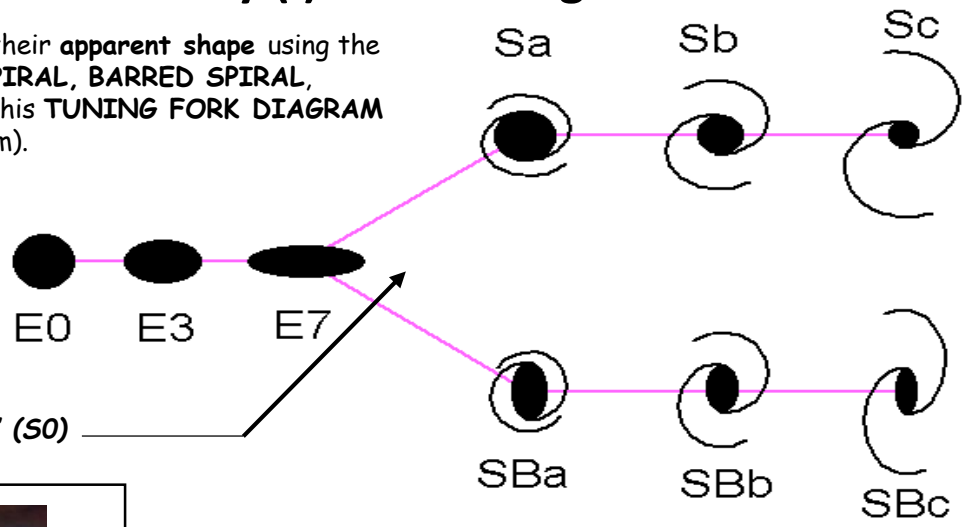


There are 5 other groups of galaxies within 10Mpc of our own, this is called a **CLUSTER**. Clusters of galaxies are **named after the constellation in which they lie**, eg. Virgo or Coma clusters. Clusters often have a giant elliptical galaxy at their center.

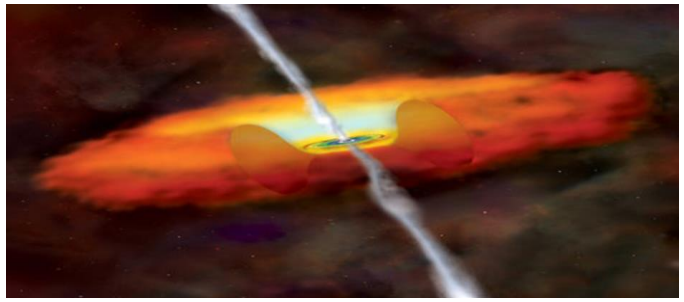
On an even larger scale, clusters may compact together due to their mutual gravitational attraction and form **SUPERCLUSTERS**.
Our **Milky Way Galaxy** is part of the **Local Group**, which is itself part of the **Virgo Supercluster**.

Galaxies are placed intone of four **CLASSES** based on their **apparent shape** using the **HUBBLE CLASSIFICATION SYSTEM**. They can be **SPIRAL, BARRED SPIRAL, ELLIPTICAL** or **IRREGULAR**. **Edwin Hubble** presented his **TUNING FORK DIAGRAM** in **1936** (irregular galaxies are not shown on the diagram).

The '**abc**' letters used alongside the spiral galaxy Codes help distinguish them according to the size of their nucleus & the openness of their arms.



*Later versions of the diagram show '**lenticular galaxies**' (S0) as an intermediate class between ellipticals and spirals.*



We can see galaxies with our eyes because they emit visible light but they also emit vast amounts of radiation at wavelengths such as radio and X-ray. Some **ACTIVE GALAXIES** have a particularly **Active Galactic Nuclei (AGN)** and so emit vast amounts of radiation at wavelengths outside of the visible spectrum. There are 3 types of AGN that are all powered by a **CENTRAL SUPERMASSIVE BLACK HOLE** that has a **mass** between **6-9 magnitudes greater than a stellar black hole** created during a supernova. Due to its vast mass the AGN pulls matter towards it forming an **ACCRETION DISC** in which stellar matter is being **accelerated** into the black hole and **GALACTIC JETS** of electrons & positrons are emitted at near to the speed of light in two narrow beams (**see diagram above**).

<u>The 3 types of ACTIVE GALAXIES</u>

SEYFERT galaxies – discovered by Carl Seyfert in 1943.
BRIGHT NUCLEI & a strong emitter of **IR, UV** & **X-ray.**

QUASARS – discovered by Allan Sandage in 1964.
Strong emitters of **UV, X-ray & RADIO.**
Appear '**star-like**' & have **LARGE REDSHIFTS.**

BLAZARS (BL LACERTA OBJECTS) – **compact quasars** where the **galactic jet** produced happens to be **pointing towards us**!