

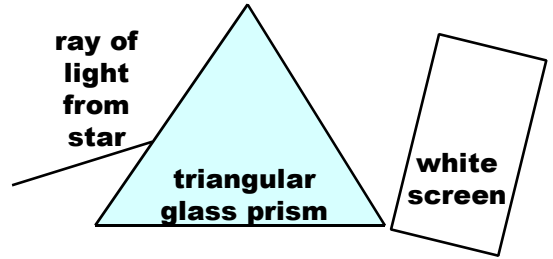
# The Universe - Origin and Evolution

## • Red Shift - Stars Moving Away From Eachother

When we pass a **ray of light** from the **Sun** (**Earth's star**) through a **triangular glass prism** onto a **white screen**, we see a **rainbow** (properly called a **visible spectrum**) on the **screen**.

Never look directly at the Sun - It can **blind you** !

On the **visible spectrum**, there is a **pattern of black lines**. From the **position** of this **black line pattern**, scientists can identify the **materials present in the atmosphere surrounding the star**.



**Simplified spectrum from the Sun**

If we do the same with light from a **star much further away** than the **Sun**, we obtain the same **visible spectrum** - but the **pattern of black lines** has **shifted (moved)** to the **right**, towards the **red end** of the **spectrum**. This is known as **red shift**.

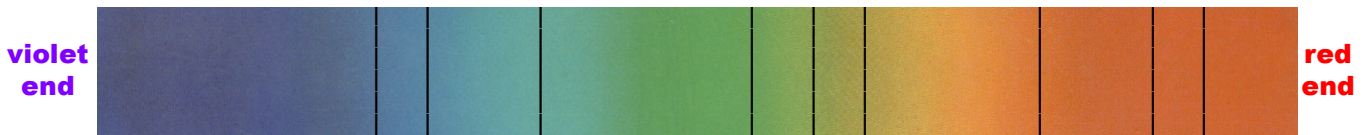
The **red shift** tells scientists that the **star** (an therefore its **galaxy**) is **moving away from Earth**.



**Simplified spectrum from a star much further away than the Sun**

If we do the same with light from a **star even further away**, we obtain the same **visible spectrum** - but the **pattern of black lines** has **shifted (moved) even more to the right**, towards the **red end** of the **spectrum**. There is a **larger red shift**.

This **larger red shift** tells scientists that the **further away star** (an therefore its **galaxy**) is **moving away from the Earth even faster than the closer star**.



**Simplified spectrum from a star even further away**

**Stars** (and their **galaxies**) are moving away from **Earth** and our **Sun** - So they must also be **moving away from eachother**.  
 The **further away** a **star** is, the **faster** it moves away.  
 This shows that the **Universe** is **expanding (getting bigger)**.

# • The Big Bang - Creation of the Universe

Because **galaxies** are **moving apart**, scientists believe that **all the material in space** must at one time have existed in only **one tiny place**.

There must have been a **huge explosion** (the **Big Bang**) which threw the material outwards in every direction. **Red shift** indicates that the **material** (now in the form of **stars, planets, dust**, etc) is **still expanding** (**moving outwards**).

Scientists estimate that the **Big Bang** happened about **15 000 million years** ago.

hap-



About **15 000 million** years ago, all the material in space existed in **one tiny place**.

There was a **huge explosion** (known as the **Big Bang**) which threw the material **outwards in every direction**.

The material is still **expanding** (**moving outwards**).

## • Future of the Universe

The future of the **Universe** depends on **how fast its galaxies are moving apart** and **the amount of material present in it** - the **critical amount**. These values are so difficult to find out that scientists still do not know the answers.

### • amount of material less than critical amount

If the **amount of material** in the **Universe** is **less than** the **critical amount**, the **force of gravity** will **not** be able to slow down the **expansion** - The **Universe** will **keep on expanding** (**moving outwards**) **for ever**.

### • amount of material more than critical amount

If the **amount of material** in the **Universe** is **more than** the **critical amount**, the **force of gravity will** be able to slow down the **expansion** - The **Universe** will **stop expanding** and **begin contracting** (**moving inwards**).

**All of the material** in the **Universe** will eventually be **squashed together** once again in **one tiny space** - Scientists call this idea the **Big Crunch**.

There could then be another **Big Bang** - The process of continuously **expanding** and **contracting** could go on **for ever**!

The **future** of the **Universe** depends on **the speed at which it is expanding** and **the amount of material present in it**.

If the **amount of material** is **less than** the **critical amount**, the **force of gravity will not** be able to stop it **expanding forever**.

If the **amount of material** is **more than** the **critical amount**, the **force of gravity will stop it expanding** and **make it contract** (**move together**) - Eventually, **all of the material** will again be **squashed together in one tiny space** - The **Big Crunch**. There could then be another **Big Bang** - The process of **expansion** then **contraction** could go on **for ever**.