# PROFESSOR SMARTT'S GUIDE TO THE UNIVERSE

Presented by Smartt science

### THE SUN AND OTHER STARS

Our Sun is just one out of around 100 billion stars in our Galaxy, The Milky Way. On the clearest, darkest of nights, away from any light pollution, you can get a glimpse at just how many stars are out there.

Many of these have their own planetary systems, just like our Solar System.

You can't see all 100 billion stars in our Galaxy with your own eyes. You can see about 4000 on any one night.

### WHAT ARE STARS?

- Stars are giant balls of very hot gas.
- The gas is mostly hydrogen (70%) and helium (28%).
- The other 2% includes <u>all</u> the other elements in the periodic table.
- Stars are massive, they are trying to collapse under their own weight.
- But what keeps them up and what makes them so bright ?

- Stars are essentially giant nuclear reactors.
- Nuclear reactions in the centre of a star produce energy. This is when 4 hydrogen atoms combine together to give 1 helium atom.
- This reaction exactly balances the stars' gravity, so they are (almost) perfect spheres.
- This needs very high temperatures, more than 14 million<sup>o</sup>C.
  - Each nuclear reaction releases a tiny amount of energy, but it happens 10<sup>38</sup> times per second in the Sun.

## OUR NEIGHBOUR: THE ALPHA CENTAURI SYSTEM

- Alpha Centauri is a **Binary Star System**, meaning it consists of two stars that orbit each other.
- Alpha Centauri A, also known as Rigil Kentaurus is similar in size, age and luminosity to our Sun.
- Alpha Centauri B, or **Toliman**, is slightly smaller and dimmer.
- There is also a third star, Proxima Centauri, which orbits around the two central stars. It is a red dwarf, 7 times smaller than the Sun, and is the closest star to our Solar System.



Credit : Wikipedia (large image), NASA, Hubble for inset

# ACTIVITY

Let's work out how long it would take us to get to our nearest neighbour star, Alpha Centauri.

Right: NASA's Voyager 1 being loaded into its capsule. The capsule was attached to a rocket for launch, then the spacecraft emerged from it in space back in 1977. It is still travelling and has reached the edge of the Solar System.



#### How long would it take to travel to our nearest star?

You saw in the lesson that our nearest star is Proxima Centauri. It is at a distance of 4.2 light years from Earth. Let's work out how long it would take a human made spacecraft to get there.

Remember that this is the **closest** star to us in the Galaxy. The Galaxy is 10,000 times bigger than the distance between Earth and Proxima Centauri. These are very big numbers, let's see if we can understand the scale of the distances between stars.

We call the distance between the Earth and the Sun "1 Astronomical Unit". It is actually 150,000,000 kilometres! But let's call it 1 AU (where AU stands for Astronomical Unit).



The distance from the Sun to the edge of the Solar System is 130 AU. That is when we enter interstellar space.

The space probe Voyager 1 was launched by NASA in 1977 and it took 36 years to reach the edge of the Solar System.

Proxima Centauri is 278,000 AU from earth. How long would Voyager take to reach Proxima Centauri?

First work out how long it takes Voyager 1 to travel 1 AU.

Now work out how long it takes to travel 278,000 AU.

Do you think humans could ever reach our nearest star? Why?

# THE SUN

- Our star the Sun, is a 4.5 billion year old yellow dwarf. It is a medium sized star, and just as we orbit it, it orbits the centre of our Milky Way galaxy.
- You could fit 1 million Earths into the Sun, if it were hollow.
- Eventually, when all of its hydrogen is burned, the Sun will swell up to the size of a **Red Giant**, consuming Venus, Mercury and Earth. It will then shrink down to a **White Dwarf**, a star about the size of Earth. However, this won't happen for another 5 billion years or so.

### **BINARY STAR SYSTEMS**

You may think of planets with two suns as a made-up idea from Star Wars, but in reality most star systems are like this. The Alpha Centauri system, and the fictional Tatooine system are just two of many.

### HOW STARS ARE BORN

- A star begins its life in a cloud of dust and gas. Large bits clump together, and start to collapse under the weight of their own gravity. This creates pressure on the core of the clumps, causing them to heat up and become **Protostars**, eventually they may get hot enough and large enough to become full stars.
- The leftover dust and gas will form the planets and asteroids of the system.
- We can see this happening all over the Galaxy.

NASA, ESA, M. Robberto (Space Telescope Science Institute/ESA) and the Hubble Space Telescope Orion Treasury Project Team

### **OBSERVATIONS OF A SOLAR SYSTEM FORMING**

- This is an amazing image of a disk of gas and dust around a young star.
  - This shows a solar system in the process of forming.
- The rings will condense into planets.
- This is about the size of our own Solar System (about 200 astronomical units across).

### THE LARGEST STARS



There are stars called **red supergiants** that are much much larger than our Sun. The biggest known is **VY Canis Majoris**, 2100 times bigger than the Sun. If we put it in the Sun's place, it would extend past the orbit of Saturn!

### VY Canis Majoris



### HOW STARS DIE

Neutron star Eventually, stars will run out of fuel to convert into energy. When this happens, they collapse under the immense weight of their own gravity. If it is a large star (around 15 times the mass of the Sun), this collapse will trigger an explosion called a **supernova**.

 After the explosion, the supernova will shrink down into an object around the size of a city called a **neutron star**. These are the densest objects in the Universe – imagine fitting the mass of the entire human race onto a teaspoon!

# Fill in the question sheet.

ACTIVITY

## The Sun and Other Stars

- 1. Approximately how old is the Sun?
  - a. 450 years old
  - b. 2.5 million years old
  - c. 4.5 billion years old
- 2. Name the star that orbits Alpha Centauri A & B.
  - a. Barnard's Star
  - b. Proxima Centauri
  - c. Toliman
- 3. Fill in the blanks. What is it called when a star, collapses under its own weight and explodes?

S\_P\_\_N\_\_A

- 4. VY Canis Majoris is \_\_\_\_\_ times the <u>radius</u> of the Sun.
  - a. 21 b. 210
  - c. 2100
- 5. VY Canis Majoris is \_\_\_\_\_ times the mass of the Sun.
  - a. 25
  - b. 250
  - c. 2500

6. True or false: Most solar systems have TWO or more stars.



- 7. What kind of star is our Sun?
  - a. Yellow Dwarf
  - b. Red Giant
  - c. Neutron Star
- 8. What is the term for the release of plasma that often follows a solar flare?



 From 1 to 6, label the lifecycle of a massive star (one that is massive enough to explode)
Some answers have been filled in for you.

Nebula	1
Star	
Supernova	
Protostar	
Red Super Giant	
Neutron Star	6



## BONUS ACTIVITY

As a class, come up with some questions about the Solar System and tweet them to Professor Smartt.

### @smarttscience



#### How long would it take to travel to our nearest star? Answers

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First work out how long it takes Voyager 1 to travel 1 AU.

To travel 1 AU = 36 ÷ 130 = 0.28 years

Now work out how long it takes to travel 278,000 AU.

To travel 278,000 = 0.28 x 278,000 = 77,840 years

Do you think humans could ever reach our nearest star? Why? To get there in a human lifetime (70 years) we would have to send a spacecraft that is 1000 times faster than Voyager 1. That is currently beyond our capability, but perhaps in the future we will be able to.

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  - a. Barnard's Star

<mark>b. Proxima Centauri</mark>

c. Toliman

3. **Fill in the blanks.** What is it called when a star, collapses under its own weight and explodes?

#### <mark>SUPERNOVA</mark>

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a. 21 b. 210 <mark>c. 2100</mark>

- 5. VY Canis Majoris is \_\_\_\_\_ times the <u>mass</u> of the Sun.
  - <mark>a. 25</mark> b. 250 c. 2500

6. True or false: Most solar systems have TWO or more stars.



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- b. Red Giant
- c. Neutron Star
- 8. What is the term for the release of plasma that often follows a solar flare?

#### <mark>CORONAL MASS</mark> EJECTION

 From 1 to 6, label the lifecycle of a massive star (one that is massive enough to explode)
Some answers have been filled in for you.

Nebula	1
Star	<mark>3</mark>
Supernova	<mark>5</mark>
Protostar	<mark>2</mark>
Red Super Giant	<mark>4</mark>
Neutron Star	<mark>6</mark>

