Life and Death of a Star The Universe Season 1 Episode 10

The beginning of a star

The Pillars of Creation – part of the Eagle Nebula - A Stellar Nursery

The key component of stars is \_\_\_\_\_\_\_\_\_Hydrogen\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

What does Gravity have to do with the beginning of star?

Gravity pulls H together to form clumps of gas, smaller clouds, a few dozen to thousands of stars

For our star, the cloud of gas and dust has to be100 times the size of the solar system. Stars the most basic unit of mass in astronomy. Heat begins to climb as gravity compresses gas.

Protostar:

100 thousand years – flattened disk, gravity pulls center into sphere, 2 million degrees. Glows with light After 10 million years later; past 18 million degrees; thermonuclear fusion can begin

Thermonuclear fusion:

Small atoms become bigger atoms; H atoms fuse together to make a helium atom and light. A star is when fusion is happening.

Main Sequence:

Gravity is always pulling a star in, trying to crush it. Pressure from moving particles pushes out against gravity. The force of gravity and pressure are equal. A star can spend most of its life in this stage.

Some MS stars large, other smaller. Color of a star is related to its temperature.

Red Dwarf stars

½ to 1/10 the mass of the Sun; Surface temperatures less than 7,000° Fahrenheit; The most common type of star. Can’t see these common stars, they are too faint.

Blue Main Sequence

Surface temp of 45,000° Fahrenheit; Up to 20 times the mass of the Sun; Up to 10,000 times more luminous

The fundamental thing that determines the length of a star’s lifetime is \_\_\_\_\_\_\_Mass\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Larger stars = \_\_\_shorter\_\_\_\_\_\_ lifetime Smaller stars = \_\_\_\_longer\_\_\_\_\_ lifetime

Million of years tens of billions of years

Why is this relationship true? A larger star burns its fuel faster.

Life on the main sequence can only last as long as there is \_\_\_\_\_\_\_\_fuel\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

When fuel runs out, gravity wins and star will start to collapse.

Larger stars = die in violent fury Smaller stars = slowly fade away

Lower to medium mass stars like our Sun: eventually the star will run out of hydrogen. 5 billion years from now the Sun will reach this stage. Nuclear fusion will stop. The core has to be hotter to get Helium fusing. Harder to get Helium nuclei close together enough to fuse. 180 million ° will allow the Helium to fuse.

Planetary Nebula:

100 million years burning Helium. The other layers of the star swells because of the heat from Helium fusing. The outer layers will be jetted off, making a planetary nebula. There are shells of gas that has been ejected. Gravity begins to pull the mass star in.

White Dwarf:

Electrons don’t like being compressed. Gravity pull them in gets them so close in the core, electron degeneracy pressure takes over. Gravity can’t win. The star will slowly cool. It is very dense – 300,000 times the mass of the earth in about the size of the earth. It will continue to shine for a billion years – a retired star. Our Sun will end up like this.

Supernova:

Type 1A: A thermonuclear runaway: If a white dwarf has a companion star, a binary star system, a white dwarf can have a different ending. A white dwarf can take the material (hydrogen) from a companion star. If its mass gets to about 40% more than the mass of our sun, you get a thermonuclear runaway explosion, a type 1A supernova. Visible light is only 1/10 of the total energy given off in a supernova explosion

Type 2: Eight or ten times more massive than the Sun. Massive stars can burn Helium and larger atoms. The star can fuse hydrogen into helium, Helium into carbon and oxygen, oxygen into neon, magnesium, until you get to iron. Fusion of iron does not give off energy (exothermic), it absorbs it (endothermic). When you get to iron in the core, gravity will start winning again, since there is not thermal pressure to push out. The iron core collapses and rebounds against the outer layers causing a huge explosion. The forces of the explosion cause the atoms to move faster and collide with each other, fusing together. The force also spreads these atoms out into space.

What do these supernovas have to do with you, your body and the Earth?

The elements making up our bodies or the Earth come from these explosions and the nuclear reactions in a star.

Neutron Stars:

After a type 2 supernova, the core is compressed to something about 10 miles wide. The electrons combine with protons to make neutrons. The core can now be compressed to a certain point, smaller than a white dwarf. Neutron stars spin. They have a strong magnetic field. Electrons move along the field lines and give off light. They are like a lighthouse beam. We call these pulsars.

Black Holes:

Larger massive stars (>25, 40 times the mass of the Sun) have so much mass that in the collapse of the iron core, not even a neutron star forms. Gravity crushes them into a black hole. Matter is compressed into such density that the gravity field is enormous. Light can’t leave because the gravity is so strong. There is limit to where you will get pulled into a black hole.

3rd type of supernova SN 2006GY

In 2006 a different SN was seen. Total energy emitted 100 times the energy of a normal supernova type 2. This star seemed to be 100 – 250 times the mass of the Sun.

The first generation of stars were like this star, a super massive star. Their SN explosions produced the atoms of elements heavier than iron that got spread out in the universe.

Collisions of Stars:

It is hard to see these in telescopes (they look like a blob of light) so computer simulations are used to study these.

Blue Stragglers:

Some parts of the galaxy are crowded and the chance of stars collide is greater. The neighborhood our Sun is in is pretty empty. Globular clusters are more crowded. Once in 10,000 years stars may combine. Because globular clusters are old, they are not expected to have young blue stars. But some have them.

Why are there blue stragglers in globular clusters?

Two older stars merge, making a more massive star that burns hotter, bluer

Brown Dwarfs:

Failed stars. They have lower temperature and emit less light because they don’t have enough mass to generate fusion. Can only see them if they are close to us. They seem to have disks around them which might form planets.

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Thermonuclear fusion:

Main Sequence:

Red Dwarf stars

Blue Main Sequence

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Why is this relationship true?

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Lower to medium mass stars like our Sun:

Planetary Nebula:

White Dwarf:

Supernova:

Type 1A: A thermonuclear runaway:

Type 2:

What do these supernovas have to do with you, your body and the Earth?

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Brown Dwarfs:

Make some kind of graphic or flow chart showing the stages of stellar evolution, from the beginning to the end. Be sure to show how different mass stars (low mass, medium mass, high mass, higher mass) follow different paths.

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