IN Today's Presentation, I'll be going over star deaths, but more specifically, planetary nebulas and neutron stars

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What are stars

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Stars are the building blocks of the galaxy. They are huge celestial bodies, held by their own gravity, mostly containing hydrogen and helium that produce light and heat. In simpler words, stars are just gigantic balls of gas. Infact, our own sun is a star. All the twinkling dots we see in the night sky are billions of stars scattered, lightyears away, around our galaxy.

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Brief history of star death observations.

Chinese astronomers in 185 AD were some of the first ones to observe and write about a supernova while the brightest supernova event in history was recorded by a famous Egyptian astronomer, Ali ibn Ridwan.

Due to conservation of energy laws dating back to 1840, it was natural to establish a star's finite lifetime as a star's energy was calculated by astronomers.

The most popular theory in the 19th century was that stars converted gravitational energy into heat.

Modern research and science has far advanced to understand the scientific phenomenon behind star deaths. Which I will go over this presentation. Usually a star death is only determined after witnessing its aftereffects. However, for the first time in 2020, the University of Hawaii watched a red supergiant actually explode which they explained as a “ticking time bomb”. As we can not determine the exact time a star will explode.

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Star births:

Stars are formed from stellar nebulas which are dense clouds of mostly hydrogen gas and dust. Over the course of thousands of years dense matter pockets in the nebula collapse and shrink under its own weight due to gravity.

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These masses of gas are classified as protostars and as they get smaller and spin faster due to the law of conservation of angular momentum the energy and pressure allows the core to emit more heat. Millions of years later when the temperature reaches around 10 to 15 million degrees Celsius, a nuclear fusion begins to happen and a new star is formed.

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Nuclear fusion:

A star's nuclear fusion process is a series of events that transform 4 hydrogen atoms into 1 helium atom. Two nuclei merge to form a single heavier nucleus. Since there is leftover mass, it releases in the form of energy, so basically light and heat. As you can see from this diagram gamma rays and neutrinos are produced in the process

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Life cycle of star

This is the main sequence where the star spends 90% of its life in the nuclear fusion state. Our own sun is currently in the main sequence and will remain so for 5 billion years.

As you can see through this life cycle, the average star will go on to become a planetary nebula while the massive star will turn into a neutron star.

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Planetary nebulae

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Starting off with the average sized stars, when they die, their surface grows in size to become a red giant while its core shrinks. This means that it no longer has enough gravity to hold onto the star's outer layer, this is when the star starts to shed its outer layers, which form a colourful and mesmerising cloud of gas and plasma called a planetary nebula. They expand at a rate of 20-50 km per second which means that this phase of glory is relatively shorter as it is only a few thousand years before the nebula disperses into space and is on its way to the next stage in the life cycle.

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Ultraviolet light is emitted by the core and is intercepted by atoms, allowing photoionization; removing the electrons from the atom. They collide with other atoms and ions to cause strong emission lines of many materials such as hydrogen, oxygen, nitrogen and since they are on the visible light spectrum, we can see their beautiful and rich colours in the cosmos.

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Supernova:

On the other hand, massive stars are destined to die in an explosion called a supernova. This happens when a star produces iron in its core due to complex nuclear fusions. This causes the star to run out of fuel and having no way to support its own mass, its iron core collapses and the star explodes producing an unimaginable amount of energy.

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Neutron stars

The gravity compressing the collapsing core is so powerful that the positively charged protons and negatively charged electrons combine into uncharged neutrons. Balancing the protons and neutrons. This is how neutron stars are formed. Neutron stars are extremely dense compact stars that produce no heat. Gravity on these stars is 2 billions times the gravity on earth.

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One type of neutron stars are pulsars:

A pulsar is a highly magnetised neutron star that rotates and emits beams of electromagnetic radiation out of its magnetic poles.

Due to a neutron star's short rotational period and energy there is a creation of electromagnetic beams emanating from the magnetic poles. The beam of radiation light when observed from the earth has a pulsing appearance. These pulses have very precise intervals that range from milliseconds to seconds.

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Societal benefits.

This property makes them a very useful tool for astronomers as some pulsars have even exceeded the accuracy of atomic clocks in keeping time.

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The study of stars is crucial as their life and death are responsible for elements that make up everything on earth. This can be seen through this periodic table showing how almost all elements originated from a star. Some elements noted in supernovas have not even been found on earth yet!

Here are my references and thank you for listening to my presentation.

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