International Federation of Trekkers

Federation Academy

Academy Course

Space Science: Stars & Our Sun

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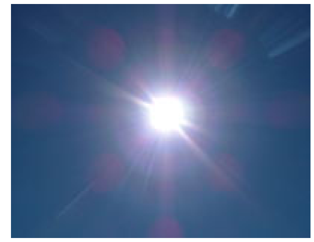
Printings

Original Edition
First Printing……………………….August 18th, 2005
Second Printing…………………...September 18, 2006

What is a Star?

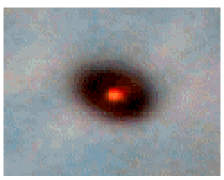


A star is a huge, gaseous celestial body in the sky. Our own Sun is a star. It is the only star close enough to the Earth to look like a ball. Other stars are much to far away from Earth to look like nothing more than pin points of light. It is estimated that there are approximately 70 sextillion (70×10^{22}) stars in the known universe. The largest star would more than fill the space between Earth and the Sun. These types of stars have a diameter that is about 1000 times as large as the Sun's. The smallest stars may be even smaller than the size of our Earth.

Looking into our night skies, you will notice that the stars seem to twinkle. Stars twinkle because starlight comes to us through moving layers of air that surround the Earth.

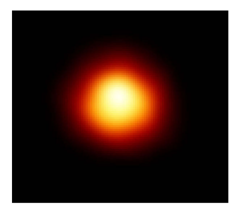
Stars are made up of two gases, hydrogen and helium. Stars shine because nuclear energy makes the gases extremely hot. Most stars began shining between 1 million and 10 billion years ago. New stars are still forming within clouds of gas & dust of the Milky Way and other galaxies. The Sun itself developed from a rotating mass of gas & dust.

How Stars Form



A star begins its luminous career by condensing out of interstellar material, dust and hydrogen gas… in other words, a cloud. Astronomers believe some of the hydrogen & dust may come from old stars. The cloud may include the remnants of a star that has exploded or it might include a collection of gases thrown from the surface of rotating stars.

Over a period of millions of years, the gas & dust cloud contract as gravity pulls it together to form a ball. At this point a protostar has been formed.



As the pressure of the gas increases the center of the protostar to become extremely hot. When the temperature reaches 2 million degrees Fahrenheit (1.1 million degrees Celsius), the hydrogen in the center of the protostar is changed to helium through nuclear fusion and gives off heat. All the gasses in the cloud begin to shine and thus the protostar has entered what astronomers call "Main Sequence" and a new star is born.

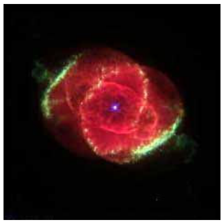
The type of star that takes shape will depend on the mass of the contracting cloud. A cloud with a mass of about 1/20 of our sun will become a red, low-luminosity star. A cloud with a mass of about 50 times that of our own sun will become a blue, high-luminosity star.

How Stars Die

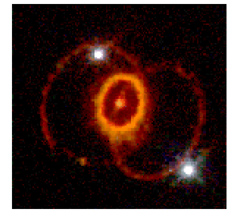
Stars begin to slowly change after they start to shine. The speed of these changes depend on how rapidly the nuclear fusion burns off the hydrogen fuel. Large stars burn their hydrogen fuel more rapidly. Thus larger stars have shorter life spans (only a few million years). Smaller stars burn their fuel at a much slower and will have life spans in the range of hundreds of billions of years. This is one example where bigger is not always better.

A star changes because the hydrogen fuel decreases. The center of the star will begin to contract and the temperature & pressure at the core will rise. At the same time, the temperature at the outer part gradually drops. The star expands greatly and becomes a red giant.

How Stars Die (cont'd)

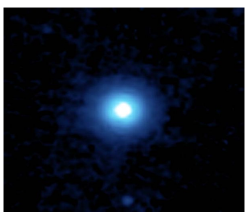


What takes place after the stars red giant phase depends on how much mass the star is made up of. A low mass star will throw off its outer layers. The outer layers will form a planetary nebula and the star itself will become a white dwarf. Stars with masses in the medium and large category will both undergo a super-nova following hydrogen exhaustion, but the final results due to star mass vary. A star with a medium mass will form a neutron star following hydrogen Exhaustion; however, larger mass stars take a much more violent route. A star with large mass may briefly form a neutron star, but following the supernova explosion, space is warped from the explosion and a black hole is left in place of the star.



Kinds of Stars

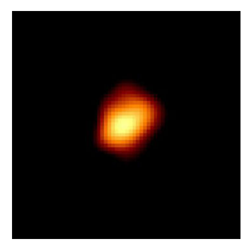
Stars are classified in several ways. They my be classified by color, brightness, and size. They may also be classified according to their characteristics that include main-sequence stars, giants, and super-giants.



Main-Sequence Stars are ordinary stars like the sun. 90% of the stars that we can see from Earth are stars of this type. Main-sequence stars include stars of all colors and brightness. They have medium-sized diameters and they are so much smaller than giants or super-giants that they are sometimes called main-sequence dwarfs; however, they are much larger then white dwarfs.

Main-sequence stars have one common characteristic. If they were all viewed at the same distance from Earth, all stars of the same color would appear equally bright. Blue stars would the brightest. White would be next; followed by yellow and orange. Red stars would be the dimmest of the group.

Giants and Super-giants are larger than main-sequence stars. They also have a higher luminosity. These stars are also different in their characteristics, such as pressure & density of their gases.



Some of the giant stars, such as Rigel, shine with a blue light. This indicates their high temperature. These types of stars have a higher density then our Sun or other main-sequence stars.

Other giants, such as Arturus, shine with a reddish glow. This indicates low temperature. Red giants are somewhat larger than blue giants. They also consist of gases under low pressure, with a density less than that of sun-like stars.

Super-Giants, such as Betelgeuse, shine with a low-temperature red color. The gases that make up a Super-Giant spread through a space so large that they may have a lower density than the air we breathe.

Kinds of Stars

White Dwarfs are smaller than main-sequence stars and have a lower luminosity. They shine with a hot, white light. Most astronomers agree that gravity within these stars has shrunk them to their small size. Gravity produces extremely high gas pressure and density in white dwarf stars. These small stars are so dense that a spoonful of their gases would weigh a few tons if it could be weighed on Earth.

Variable stars alternate between shining brightly and then dimly. There are three principal types of variable stars: (1) pulsating variables, (2) exploding stars, and (3) eclipsing binaries.

> **Pulsating variables** change in brightness as they expand and contract. The time it takes for this type of star to change from bright to dim to bright again is called its period. Pulsating variables include short-period variables, long period variables, and irregular variable. Short period variables are yellow super-giants. Many of them pulsate about once a week. The North Star is a short-period variable with a period of about four days. Long period variables are red giants or super-giants. Many of them have periods that last hundreds of days. Irregular variables do not have a regular period.
>
> **Exploding stars** burst unexpectedly with such tremendous energy that they hurl huge amounts of dust and gas into space. One type of exploding star is called a nova. It becomes a thousand time brighter than normal. This extreme brightness may last a few days or even years, and then the star returns to its dim appearance. Some novae explode again and again after indefinite periods. Another type of exploding star is a supernova. A supernova is thousands of times as bright as an ordinary nova.
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> **Eclipsing binaries** are double stars, such as Algol. They consist of a pair of stars that move around each other. The stars move in such a way that one periodically blocks the others light. This blocking reduces the total brightness of the two stars as seen from the Earth.

Binary Stars consist of visual binaries and spectroscopic binaries. Either kind may also be an eclipsing binary.

> **Visual binaries**, when seen through a telescope, look like two stars revolving around each other. Just one revolution of these stars may take 100 years.
>
> **Spectroscopic binaries** look like single stars, even through a telescope. They have been named after the spectroscope, the instrument that astronomers use to identify them. Spectroscopic binaries complete their revolution around each other in a few days or a few months.

Two stars of the Big Dipper are well known binaries, Mizar and Alcor. Both these stars can be seen without the use of a telescope.

Distance of the Stars

The Sun is about 93 million miles away from Earth. The star nearest to the sun is Proxima Centauri. It seems as if it were no more than a pin point of light, but in reality it is 625 trillion miles away (6.25×10^{14}) from Earth.

The distance between the stars is measured in units called light years. Proxima Centauri is 4.3 light years from the sun. A light year equals 5.88 million, million miles. This is the distance light travels in one year at the speed of 186,282 miles per second. Some stars in the Milky Way are as far as 80,000 light years from the sun.

The Milky Way's closest neighbour is a galaxy 200,000 light years away.

The sun belongs to part of the Milky Way where distance between stars average 4 to 5 light years. In some other parts of the galaxy, the stars are much closer. In globular clusters, less than 1/100 of a light year separates the stars.

Bibliography

The exam received some updating before second printing. The following sources were used during the second printing update.

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