



Stars of the Universe

Transcript

Speaker 1: Sometimes, people think of space as nothing, a void, but there's a lot happening out there. The universe is alive with other worlds and stars that are red, yellow, white, and blue. Stars are born, live, and die, often in spectacular fashion. Our nearest star is what sustains life on this planet, but our sun is just one of thousands of trillions of stars. When we look into the sky away from the city lights, we can see millions of them. Through a telescope, we can see billions.

Distances in space are incredibly vast. We measure them in light years, that is, the distance that light travels in one year. It takes light from the sun eight minutes to reach the Earth, half an hour to Mars, forty-five minutes to Jupiter, and four years to reach our nearest star neighbour, Alpha Centauri.

Our sun is one of billions of stars that make up the Milky Way, a type of galaxy known as a spiral galaxy. Our solar system is one of the galaxy's spiral arms. The Milky Way, together with at least forty nearby galaxies, make up what's called the Local Group, which is part of a group of thousands of galaxies called the Supercluster.

The Milky Way contains more than one hundred and fifty global clusters. These are smaller groups of stars, comprising mostly of old, red stars packed closely together. Omega Centauri is the largest and brightest globular cluster. It's approximately a hundred and fifty light years across, and contains an estimated ten million stars, that are between ten and twelve billion years old.

Galaxies in the universe are moving away from one another. The further away they are, the faster they travel. Scientists have found that by tracing back along their paths, it can be shown they are all originated in the same place, about fifteen billion years ago. The best explanation is that there was a massive explosion that started the formation of galaxies, and caused them to start moving.

Before the Big Bang, the entire universe was compressed into a tiny point smaller than an atom. The massive explosion produced huge quantities of hydrogen, some helium, and a little lithium.

The spiral arms of galaxies grow by collecting gas from space. Once in the galaxy, the gravity of the gases pulls them together into clouds, and this is where stars are born. Gas falls into the centre of a cloud and forms a protostar, which is not yet hot. The gas starts to spin, forming a rotating disk and planets are created in the disk, as the protostar in the centre collects more and more hydrogen. As the gases in the protostar become more compressed, they grow very hot. When their temperature reaches five to ten million degrees, an atomic fusion reaction occurs between the hydrogen atoms.





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This is just one of many steps in forming all the different elements of the universe. Stellar winds form when heat drives away a lot of the gas. This phenomenon has been seen in many images sent from the Hubble Space Telescope. This is a cluster of hot, blue stars. Fusion reactions occur in the core of stars, where there is sufficient pressure. Heat, light, and radiation bounce around inside the star from one hundred thousand years, or more before reaching the surface, the energy that leaves the star in the form of heat, light, and ultraviolet radiation.

Our solar system's large outer planets – Jupiter, Saturn, Uranus, and Neptune, are also made of gas, but they never developed into stars because they're not big enough to create the pressure and heat inside their core to generate a fusion reaction.

A star's colour depends on its temperature, which in turn depends on its size. The smallest and most common star is a red dwarf, which only just becomes red hot. Our sun is a yellow star. The fusion reaction in its core heats the surface to yellow hot. The biggest stars become white hot. Blue stars are the biggest and hottest of all. These blue stars in a cluster called Pleiades are between forty to one thousand times brighter than the sun. Red dwarfs take about thirty billion years to use up their hydrogen, after which they cool down and become a cold ball of gas, which is known as a black dwarf.

Yellow stars like our sun last about ten billion years. Right now, we're approaching the halfway point in its life. It's about four point six billion years old. In another five billion years, it will have used up all its hydrogen, and will start another fusion process using helium. When this occurs, the sun's brightness will dramatically increase, and its diameter will expand by about one hundred times. In doing so, it will engulf all of the inner planets, and possibly our own, to become what is known as a red giant.

A few million years later, the helium will have been used up, and the remaining gas will be blown into space as a powerful solar wind. All that will be left is a mass of gas smaller than the Earth called a white dwarf. If you could take a trip through the Milky Way, you would see the remains of many exploding stars which were once around the same size as our sun.

When a massive blue star has converted all its core hydrogen into helium, it calls and the surrounding gases are drawn to the centre by gravity. This causes further compression, and the core is heated to around one hundred and seventy million degrees. This intense heat causes the star's outer layers to expand to about one hundred times their original diameter, and the star becomes a red super giant. Inside the core of a red super giant, new reactions occur. Hydrogen is fused to helium, then to other elements, and the star eventually becomes layered, like an onion.

Not all elements that make up the layers can be fused, so the heat ceases, causing the outer layers to collapse inwards and compress the core. What follows is an enormous explosion called a supernova. When these occur, for a short time, they appear brighter than entire galaxies.





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Where massive stars collapse, heavy elements are formed in a supernova, which then combine to make planets and smaller rock fragments. In the centre of the supernova are neutron stars. These stars, made of subatomic particles called neutrons, are very small, only twenty kilometres or so in diameter, but they're incredibly dense.

A single teaspoon of neutrons weighs millions of tonnes. Some neutron stars pulsars, or pulsing radio waves. Pulsars have very powerful magnetic fields, which rotate very quickly. When the beam points towards the Earth, we can detect the pulses with radio telescopes.

When lots of massive stars collapse and a supernova follows, so much matter is squeezed into the centre that it disappears, forming a black hole. Nothing can escape a black hole – not even light, which is why it's black. If you fell into a black hole, your body would be stretched like a rubber band.

The light intensity of most stars varies over time. About every eleven years, this happens with our sun. Some stars vary in brightness a great deal, and over shorter periods. Cepheid variable stars are very bright super giant stars, and their brightness varies over a matter of just days.

Most of the stars in our galaxy belong to multiple star systems. A multiple star system has two or more stars which are in mutual orbit. Sometimes, one star is brighter than another, and if they line up, it is possible to see the duller star pass in front of the brighter one, which will appear to dim. When two stars of similar size are in mutual orbit, they revolve around a mutual centre of gravity. When one is larger than another, the centre of gravity is located closer to the bigger star.

Had Jupiter been a lot larger and formed into a star, our solar system would have been a binary system, with two stars. The more stars a system has, the less stable the orbits tend to be. Systems with four, or more stars are likely to fly apart. Planets that are part of multiple star systems have highly irregular orbits. Sometimes a star orbits with a black hole, which pulls matter off the star due to its incredible gravitational force.

Next time you gaze into the universe, think of the billions and billions of stars out there, all converting hydrogen into the elements that create matter in space. It is because of the Earth's distance from the sun, and because of the sun's incredible energy, that there is life on our planet. Given the number of stars in our universe, there's probably life on other planets too.

