Universe stars and galaxies 5th edition pdf

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Astronomical plasma spurs this article is about the astronomical object. for other oi, see the star (disambiguation.) a region that forms stars in the large image of cloudfalse magellanic color of the sun, a star of main sequence of type g, the closest to the constellation of earthlyde of leo as can be seen from the naked eye. lines were added. a star is an astronomical object made up of a luminous plasma spheroid held together by its own gravity. The star closest to the earth is the sun. Many other stars are visible to the naked eye at night, but because of their immense distance from the earth appear as fixed points of light in the sky. The most prominent stars are grouped in constellations and asterisms, and many of the brightest stars have their own names. Astronomers have assembled star catalogues that identify known stars and provide standardized stellar designations. the observable universe contains an estimate of 1022 to 1024 stars, but most are invisible to the naked eye from the earth, including all individual stars outside our galaxy, the Milky Way. the life of a star begins with the gravitational collapse of a gaseous nebula of material composed mainly of hydrogen, along with helium and traces of quantity of heavier elements. the total mass of a star is the main factor that determines its evolution and possible destiny. for most of its active life, a star shines because of the thermonuclear fusion of hydrogen into helium in its core, releasing energy that passes through the inside of the star and then radiates into space. at the end of a star's life, its nucleus becomes a stellar remnant: a white nano, a neutron star or, if it is sufficiently massive, a black hole. almost all of the elements of course that occur heavier than lithium are created by stellar nucleosynthesis in the stars or their remains. the chemically enriched material is returned to the half interstellar by loss of stellar mass or explosions of supernova and then recycled into new stars. astronomers can determine stellar properties including mass, age, metallicity (chemical composition,) variability, distance and movement through space by making observations of apparent brightness, spectrum and changes in its position on the sky. Stars can form orbital systems with other astronomical objects, such as planetary systems and star systems with two or more stars. when two stars have a relatively narrow orbit, their gravitational interaction may have a significant impact on their evolution. Stars can be part of a much larger gravitational structure, such as a star cluster or a galaxy. etymology the word star ultimately comes from the proto-Indo-European root "Hâ‚stá¸-r" which meansStar, but further analyzed as HÃ ¢ ‚ S- ("burn", also the source of the word "ash") + -tÃ¤ "R (agentitive suffix). Compare Latin Star, Greek Aster, German Stern. Some scholars believe That the word is a loan from Akkadian "Istar" (Venus), however some doubts this suggestion. Star is (It has the same root) with the following words: asterisk, asteroid, astral, constellation, Esther. [1] History of observation People played models and images in the stars since ancient times. [2] This depiction of the 1690 of the constellation of Lion, the lion is of Johannes Hevelius. [3] Historically, the stars have been important for civilizations around the world. They were part of the religious practices, used for heavenly navigation and orientation, to mark the passage of the seasons, and to define the calendars. The first astronomers have recognized a difference between "fixed star", whose position on the celestial sphere does not change, and "stamally flooding" (planets), which move considerably compared to fixed stars during days or weeks. [4] Many ancient astronomers believed that the stars were permanently affixed to a heavenly sphere and that they were immutable. By convention, astronomers welcomed prominent stars in asterisms and constellations and used them to trace the movements of the planets and the inferred position of the sun. [2] The movement of the sun against the background stars (and the horizon) was used to create calendars, which could be used to regulate agricultural practices. [5] The Gregorian calendar, currently used almost anywhere in the world, is a solar calendar based on the corner of the terrestrial rotational axis compared to its local star, the sun. The oldest stellar ranking dated was the result of the ' Ancient Egyptian astronomy in 1534 BC [6] The first known star catalogs were completed by the ancient Babylonian astronomers of Mesopotamia at the end of the II millennium A.C., during the Kassite period (c. 1531â € "1155 A.C.). [7] The first stellar catalog of Greek astronomy was created by Aristillo in about 300 A.C., with the help of Timocharis. [8] The Stellar Catalog of Hipparchus (II century A.C.) included 1020 stars, and was used to assemble the Stellar catalog of Ptolemy. [9] Hipparchus is known for the discovery of the first registered Nova (New Star). [10] Many of the constellations and the names of the stars in use today derive from Greek astronomy. Despite the apparent immutability of the skies, Chinese astronomers were aware that the new stars could appear. [11] In 185 D.C., were the first to observe and write about a supernova, today known as SN 185. [12] The brighter stellar event of the registered history was the Supernova SN 1006, which was observed in 1006 and written by the Egyptian astronomer Ali Ibn Ridwan and several Chinese astronomers. [13] Supernova SN 1054, which gave birth to the crab nebula, was also observed by Chinese and Islamic astronomers. [14] [15] [16] Medieval Islamic astronomers gave Arab names to many stars that are still used today and have invented numerous astronomical instruments that could calculate the positions of the stars. built the first major observer research institutes, mainly for the production of Zij star catalogues. [17] Among these, the Book of the Stars fixed (964) was written by PersianAbd al-Rahman Al-Sufi, who observed a number of stars, star clusters (including the Omicron Veloorum and Brocchi clusters) and galaxies (including the Andromeda Galaxy). [18] According to A. Zahoor, in the 11th century, the Persian Polymath Scholar Abu Rayhan Biruni described the Milky Way Galaxy as a multitude of fragments having the properties of nebulae stars, and gave the latitudes of various stars during a lunar eclipse in 1019. [19] According to Josep Puig, the Andalusian astronomer Ibn Bajjah proposed that the Milky Way was composed of many stars that almost touched each other and looked like a continuous image due to the refraction effect from the sublunar material, citing his observation of the conjunction of Jupiter and Mars over 500 Ah (1106/1107 AD) as evidence. [20] Ancient European astronomers such as Tycho Brahe identified new stars in the night sky (later called Novae), suggesting that the skies were not immutable. In 1584, Jordan Bruno suggested that stars were like the sun, and may have other planets, perhaps even for the Earth, orbiting them, [21] an idea that had been suggested earlier by the ancient Greek philosophers, Democritus and Epicurus, [22] and by medieval Islamic cosmologists [23] such as Fakhr al-Din al-R Nazi. [24] In the next century, the idea of stars is the same thing that the sun was reaching a consensus among astronomers. To explain why these stars did not exert a net gravitational pull on the solar system, Isaac Newton suggested that the stars were equally distributed in all directions, an idea provoked by theologian Richard Bentley. [25] The Italian astronomer Geminiano Montanari recorded observational variations in the brightness of the star's algae in 1667. Edmond Halley has published the first measurements of the correct motion of a couple of nearby "fixed" stars, proving that they have changed positions since the time of the ancient Greek Astronomers Ptolemy and Ipparchus. [21] William Herschel was the first astronomer to attempt to determine the distribution of stars in the sky. During 1780, he established a series of calibres in 600 directions and counted the stars observed along each line of sight. From this he deduced that the number of stars increased steadily towards one side of the sky, towards the core of the Milky Way. His son John Herschel repeated this study in the southern hemisphere and found a corresponding rise in the same direction. [26] In addition to his other accomplishments, William Herschel is noted for his discovery that some stars do not simply lie along the same line of sight, but are physical companions forming binary star systems. [27] The science of stellar spectroscopy was pioneered by Joseph Von Fraunhofer and Angelo Secchi. Comparing the spectra of stars like Sirius to the sun, they found differences in the strength and number of their lines of - The absorption lines - the dark lines in the star spectra caused by the absorption of the atmosphere of specific frequencies of the atmosphere. In 1865, 1865, began to classify stars in spectral types. [28] The modern version of the star rating scheme was developed by Annie J. Cannon in the early 1900s. [29] The first direct measure of the distance to a star (61 Cygni at 11.4 light years) was made in 1838 by Friedrich Bessel using the parallax technique. Parallax measurements have shown the vast separation of stars in the skies. [21] The observation of the double stars has had an increasing importance in the course of the 19th century. In 1834, Friedrich Bessel observed changes in the correct movement of the Sirius star and inferned a hidden companion. Edward Pickering discovered the first spectroscopic track in 1899 when he observed the periodic division of the spectral lines of the Mizar star in a period of 104 days. The detailed observations of many binary star systems were collected by astronomers such as Friedrich Georg Wilhelm von Struve and S. W. Burnham, allowing the masses of stars to be determined by the calculation of orbital elements. The first solution to the problem of deriving an orbit of binary stars from telescopic observations was made by Felix Savary in 1827.[30] The 20th century saw increasingly rapid progress in the scientific study of stars. Photography became a valuable astronomical instrument. Karl Schwarzschild discovered that the color of a star and, therefore, its temperature, could be determined by comparing the visual magnitude against photographic magnitude. The development of photoelectric photometer allowed precise measurements of magnitude at multiple wavelength intervals. In 1921 Albert A. Michelson made the first measurements of a stellar diameter using an interferometer on the Hooker telescope at the Mount Wilson Observatory. [31] Important theoretical work on the physical structure of the stars occurred during the first decades of the twentieth century. In 1913 the Hertzsprung-Russell diagram was developed, propelling the astrophysical study of the stars. Successful models have been developed to explain the interiors of the stars and stellar evolution. Cecilia Payne-Gaposchkin proposed for the first time that the stars were made mainly of hydrogen and helium in his doctoral thesis of 1925.[32] Star spectra were further understood through the progress of quantum physics. This allowed the chemical composition of the star atmosphere to be determined. [33] Infrared image from NASA's Spitzer Space Telescope showing hundreds of thousands of stars in the Milky Way galaxy With the exception of rare events such as supernovae and supernova impostors, the individual stars have been observed mainly in the Local Group,[34] and especially in the visible part of the Milky Way (as demonstrated by the detailed star catalogues available for our galaxy) and its satellites. [35] In the galaxies M87[36] and M100 of the Cluster of Virgo,[37]observe individual stars such as the Cepheid variables, as well as bright stars in some other relatively close galaxies. [38] With the help of the gravitational lens, a single star star Icarus) was observed 9 billion light-years away.[39][40] Main articles: Star designation, astronomical naming conventions and Star catalog The concept of constellation was known to exist during the Babylonian period. Ancient sky watchmakers imagined that the prominent arrangements of stars formed patterns, and associated them with particular aspects of nature or their myths. Twelve of these formations land along the band of the ecliptic and these became the basis of astrology. [41] Many of the most important individual stars have been given names, particularly with Arabic or Latin denominations. As well as some constellations and the Sun itself, individual stars have their own myths. [42] In the Ancient Greeks, some "stars", known as planets (Greek ÏÎ"Î±Î½Î®ÏÎ·Ï (planÄtÄs), meaning "wanderer"), represented various important deities, from which the names of the planets Mercury, Venus, Mars, Jupiter and Sat were taken. No. [42] (Uranus and Neptune were Greek and Roman deities, but neither was the planet known in antiquity because of their low luminosity. Their names were given by later astronomers.) Around 1600, the names of the constellations were used to name the stars in the corresponding regions of the sky. The German astronomer Johann Bayer created a series of star maps and applied the Greek letters as designations to the stars in each constellation. Later, a numbering system based on the correct ascension of the star was invented and added to John Flamsteed's star catalogue in his book "Historia coelestis Britannica" (edition 1712), so this numbering system was called the Flamsteed designation or Flamsteed numbering. [43] [44] The internationally recognized authority for naming celestial bodies is the International Astronomical Union (IAU). [45] The International Astronomical Union maintains the Working Group on Stellar Names (WGSN) [46] which catalogues and standardizes proper names for stars. [47] A number of private companies sell names of stars that are not recognized by the AU, professional astronomers, or the amateur astronomy community. [48] The British Library calls this an unregulated business venture,[49] [50] and the New York City Department of Consumer and Worker Protection has issued a breach against such a star-named company for engaging in a misleading business practice. [51][52] Units of Measurement Although stellar parameters can be expressed in SI units or Gaussian units, it is often more convenient to express mass, luminosity, and rays in solar units, depending on the Sun's characteristics. In 2015, the AU defined a set of nominal solar values (defined as SI constants, without uncertainties) that can be used to cite stellar parameters: Nominal solar brightness: LâŠ = 3.828 Ã 1026 W [53] solar radius R = 6.957 Ã 108 m [53] The Sun's mass MâŠ has not been explicitly defined by AU due to the large relative uncertainty (10âÂ4) of the Newtonian gravitational constant G. Since the product of di The Newtonian constant and solar gravitational mass together (GMâŠ) has been determined to a much greater accuracy, the AU has defined the nominal parameter of solar mass to be: nominal parameter of solar mass: GMâŠ = 1.3 271 244 Ã 1020 m3 sâÂ2 [53] The nominal solar mass parameter can be can be combined with the most recent (2014) CODATE estimate of the Newtonian gravitational constant G to derive the solar mass to be about 1.9885 Ã 1030 kg. Although the exact values for brightness, radius, mass parameter and mass may vary slightly in the future due to observational uncertainties, the nominal constants of AU 2015 will remain the same SI values as useful measures for quoting stellar parameters remain. Long distances, such as the radius of a giant star or the semi-major axis of a binary stellar system, are often expressed in terms of astronomical units â roughly equal to the average distance between the Earth and the Sun (150 million km or about 93 million miles). In 2012, the AU defined the astronomical constant to be an exact length in meters: 149,597,870,700 m.[53] Formation and Evolution Main article: Stellar Evolution Stellar evolution of low-mass (left cycle) and high-mass stars (right cycle), with italic examples Stars condense from space regions of higher density of matter, but those regions are less dense than inside a vacuum chamber. These regions, known as molecular clouds, consist primarily of hydrogen, with about 23 to 28 percent helium and a few percent heavier elements. An example of a star-forming region is the Orion Nebula. [54] Most stars form in groups of tens and hundreds of thousands of stars. [55] Mass stars in these groups can powerfully illuminate those clouds, ionize hydrogen, and create regions of H II. Such feedback effects, from star formation, can eventually disrupt the cloud and prevent further star formation. [56] All stars spend most of their existence as main sequence stars, powered primarily by the nuclear fusion of hydrogen into helium within their core. However, stars of different masses have significantly different properties at various stages of their development. The ultimate fate of more massive stars differs from that of less massive stars, such as their brightness and the impact they have on their environment. As a result, astronomers often group stars by their mass:[57] Stars of very low mass, with masses less than 0.5 Mâ, are fully convective and distribute helium evenly throughout the star while on the main sequence. Therefore, they never burn and never become red giants. After they run out of their hydrogen they become white dwarfs of helium and slowly they [58] Since the life of 0.5 Mas stars is longer than the age of the Universe, no such star has yet reached the white dwarf stage. Low-mass stars (including the Sun), with a mass between 0.5 MA and 1.8â2.5 MA depending on the composition, become red giants as their hydrogen core is depleted and their to burn the helium in the nucleus in a flash of helium; they develop a degenerate carbon-oxygen nucleus later on the asymptotic giant branch; finally they blow their outer shell like a planetary nebula and leave their nucleus in the form of a white dwarf. Intermediate stars, between 1.8â2.5 Mâ and 5â10 Mâ, go through evolutionary stages similar to low-mass stars, but after a relatively short period on the red-giant branch turn on the helium without a flash and spend an extended period in the red clump before forming a carbon-oxygen nucleus of the Generated. Mass stars generally have a minimum mass of 7â10 Mâ (possibly less than 5â6 Mâ). After exhausting the hydrogen in the center, these stars become supergiants and continue to melt heavier elements than helium. They end their lives when their nuclei collapse and explode like supernovae. The artist's conception of the birth of a star inside a dense molecular cloud A group of about 500 young stars is located inside the nearby star nursery W40. Main article: star formation The formation of a star begins with gravitational instability within a molecular cloud, caused by regions of higher density âoften triggered by the compression of radiation clouds by massive stars, expanding bubbles in the interstellar medium, the collision of different molecular clouds, or The collision of galaxies (as in a stellar galaxy).[60] When a region reaches a density sufficient to meet the criteria for Jeans instability, it begins to collapse under its gravitational force. [61] As the cloud collapses, individual conglomerations of dense dust and gas form "Bok globules." As a blood cell collapses and density increases, gravitational energy turns into heat and the temperature rises. When the protostellar cloud has reached approximately the stable state of hydrostatic equilibrium, a protostar form to the nucleus.[62] These pre-sequence stars are often surrounded by a protoplanetary disk and powered primarily by the conversion of gravitational energy. The period of gravitational contraction lasts about 10 million years for a star like the sun, up to 100 million years for a red dwarf. [63] The first stars of less than 2 Mae are called T Tauri stars, while those with greater mass are Herbig Ae/Be stars. These newly formed stars emit gas jets along their axis of rotation, which can reduce the angular momentum of the collapsing star and lead to small patches of nebulicity known as Herbig-Haro objects.[64][65] These jets, combined with radiation from nearby massive stars, can help push away the surrounding cloud from which the star was formed. [66] At the beginning of their development, the T Tauri stars follow Hayashi's trail, contracting and decreasing the remaining at about the same temperature. The T Tauri less massive stars follow this track to the main sequence, while the most massive stars turn on the Henyey track. [67] Most stars are observedbinary star systems, and the properties of these binaries are the result of the conditions under which they were formed.[68] A gas cloud must lose its angular momentum to collapse and form a star. Fragmentation of the cloud into multiple stars distributes part of that angular momentum. The primordial tracks transfer a certain angular moment for gravitational interactions during close encounters with other stars of young star clusters. These interactions tend to split apart from more widely separated binaries (soft) while causing hard binaries to become more closely linked. This results in the separation of the tracks into their two observed population distributions.[69] Main sequence Main article: Main sequence Stars spend about 90% of their lives melting hydrogen into helium in high temperature and high pressure reactions in the core region. These stars are said to be in the main sequence, and are called dwarf stars. From the main sequence of age zero, the percentage of helium in the core of a star will increase steadily, the rate of nuclear fusion in the core will increase slowly, as will the temperature and brightness of the star.[70] It is estimated that the Sun has increased its brightness by about 40% since it has rays. [71] Each star generates a stellar wind of particles that causes a continuous outflow of gas into space. For most stars, the loss of mass is negligible. The Sun loses 10â¢14â¢ a year,[72] or about 0.01% of its total mass over its lifetime. However, very massive stars can lose from 10¢7 to 10¢5¢¢¢¢¢ per year, significantly affecting their evolution.[73] Stars that start with more than 50¢¢¢¢ can lose more than half their total mass while they are in the main sequence.[74] Example of a Russell's Hertzsprung diagram for a set of stars including the Sun (centre) (see Classification) The time a star spends in the main sequence depends mainly on the amount of fuel it has and the speed with which it melts. The Sun should live 10 billion (1010) years. Massive stars consume their fuel very quickly and are short-lived. Low-mass stars consume their fuel very slowly. Stars with a mass of less than 0.25 MÃ¢¢¢¢¢¢, called red dwarfs, are able to melt almost all their mass, while stars of about 1 MÃ¢¢¢¢¢¢ can melt only about 10% of their mass. The combination of their low fuel consumption and the relatively large supply of usable fuel allows low-mass stars to last about one trillion (1012) years; the most extreme of 0.08 MâÂ¡ will last about 12 trillion years. The red dwarf warmer and brighter as they accumulate helium. When hydrogen is finished, they contract in a white dwarf and decrease the temperature.[58] Since the lifespan of these stars is greater than the present age of the universe (13.8 billion years), no star is expected to be below 0.85 Mâ¢[75] has gone away from the main sequence. In addition to the mass, helium's heaviest elements can carry out arole in the evolution of stars. Astronomers label all the heavier elements of helium "metals" and call the chemical concentration of these elements in a star, its metallicity. The metallicity of a star can influence the time it takes to burn its fuel and controls the formation of its magnetic fields, [76] which affects the strength of its stellar wind. [77] The oldest stars, Population II, have substantially less metallicity than the younger, the star population because of the composition of the molecular clouds from which they form. Over time, such clouds become increasingly enriched with heavier elements as older stars die and pour out portions of their atmospheres. [78] Post-â¨¬ "Main Sequence Main articles: Subgiant, Red Giant, Horizontal Branch, Red Group and Asymptotic Giant Branch Betelgeuse as seen by Alma. This is the first time that Alma has observed the surface of a star and has led to a higher resolution image of the available betelgeuse. As stars of at least 0.4 mâ€ [79] discharge the hydrogen supply to their nucleus, they begin to melt the hydrogen into a shell surrounding the helium nucleus. The outer layers of the star expand and cools greatly as they transilive into a red giant. In some cases, it will melt heavier elements to the core or into shells around the core. As stars expand, they throw some of their mass, enriched by those heavier elements, into the interstellar environment, to be recycled later as new stars. [80]. In about 5 billion years, when the sun enters the burning stage of helium, it will expand to a maximum radius of about 1 astronomical unit (150 million kilometers), 250 times its current size and lose 30% of its maximum mass. [71] [81] As the hydrogen burning shell produces more helium, the core increases in mass and temperature. In a red giant up to 2.25 m â°, the mass of the helium core becomes degenerated before helium melts. Finally, when the temperature rises sufficiently, the basic helium fusion begins to explode in what is called a helium flash, and the star rapidly shrinks in radius, increases its surface temperature and moves on the horizontal branch of the HR scheme. For more massive stars, the helium core fusion begins before the core becomes degenerate, and the star spends some time in the red clustering, slowly burning the helium, before the outer convective envelope collapses and the star then moves on the horizontal branch. [82] After a star has melted the helium of its core, it begins to melt the helium along a shell surrounding the hot carbon core. The star then follows an evolutionary path called the Asymptotic Giant Branch (AGB) which parallels the other red phase described, but with a greater The largest AGB stars can undergo a short period of carbon fusion before the nucleus becomes degenerate. During the AGB phase, stars undergo thermal impulses due to instability in the core of the star. In these thermal impulses, the brightness of the star varies and the matter is expelled from the atmosphere of the star, ultimately A planetary nebula. Up to 50 - 70% of the mass of a star can be expelled in this mass loss process. Because energy transport in a star AGB is mainly due to convection, this expelled material is enriched with melting products dredged by the core. Therefore, the planetary nebula is enriched with elements such as carbon and oxygen. Ultimately, the planetary nebula disperses, enriching the general interstellar soil. [83] Therefore, the future generations of stars are made of the "star stuff" from the previous stars. [84] Stars Massive Main items: Star Supergiant, Hypergianti and Wolf "Star of Stary Star-like-Likeer-like-like the core of a massive star and evolving just before Core collapses during their stage of Burning Helium, a star of over 9 solar masses it expands a blue and then a red surgerant. The particularly massive stars can evolve in a lup-rayet star, characterized by spectra dominated by the emission lines of heavy hydrogen elements, which have reached The surface due to a strong convection and intense mass loss, or from stripping of the external layers. [85] When the helium is exhausted to the core of a massive star, the main contracts and temperature and pressure increases enough from Melt the carbon (see the carbon burning process). This process continues, with the subsequent phases powered by neon (see the neon burning process), oxygen (see the PR Oxygen burning cheese) and silicon (see silicon burning process). Close to the end of the life of the star, the merger continues along a series of shells in onion layers inside a massive star. Each shell blends a different element, with the hydrogen of fusion of the outermost shell; The next shell that blends helium, and so on. [86] The final phase occurs when a large star begins to produce iron. Because iron cores are more closely linked than the heavier nuclei, any merger beyond iron does not produce a net energy release. [87] Collarium while the core of a star reduces, the radiation intensity from that surface increases, creating this radiation pressure on the outer shell of the gas that will push away those layers, forming a planetary nebula. If what remains after the external atmosphere has been paid is less than about 1.4 m â € °, it is reduced to a relatively tiny object on the size of the earth, known as a white dwarf. The white dwarfs do not have the mass for further gravitational compression to be carried out. [88] The degenerated matter of electrons inside a white dwarf is no longer a plasma. In the end, the white dwarfs vanish in black dwarves for a very long period of time. [89] The crab nebula, the remains of a supernova who was For the first time about 1050 D.C. In massive stars, the merger continues until the iron core grew so large (more than 1.4 m â €) which can no longer support its mass. This nucleus suddenly will be as its electrons are guided in its protons, forming neutrons, neutrinos and gamma rays in a burst of electrons capture and inverse beta decay. The shockwave formed by this sudden collapse causes the rest of the star to explode in a supernova. supernova. become so bright that they can briefly externalize the entire domestic galaxy of the star. When they occur within the Milky Way, supernovae have historically been observed by naked eye observers as "new stars" where no one apparently existed before. [90] A supernova explosion wipes out the outer layers of the star, leaving a remnant like the Crab Nebula. [90] The nucleus is compressed into a neutron star, which sometimes manifests itself as a button or an X-ray explosive.In the case of larger stars, the residue is a black hole larger than 4 Mâ. In a neutron star matter is in a state known as neutron-degenerate matter, with a more exotic form of degenerate matter, QCD matter, possibly present in the nucleus.[92] Blown-off outer layers of dying stars include heavy elements, which can be recycled during the formation of new stars. These heavy elements allow the formation of rocky planets. The outflow of supernovae and the stellar wind of large stars play an important role in modelling the interstellar medium. [90] Binary stars The evolution of binary stars can be significantly different from the evolution of individual stars of the same mass. If the stars in a binary system are close enough, when one of the stars expands to become a red giant it can overflow its Roche lobe, the region around a star where the material is gravitationally bound to that star, leading to material transfer to the other. When the Roche lobe is overflowed, a variety of phenomena can lead to results, including contact binaries, common-envelope binaries, cataclysmic variables, blue stragglers,[93] and type Ia supernovae. Mass transfer leads to cases like the Algol paradox, where the most evolved star in a system is the least massive. [94] The evolution of binary and higher-order stellar systems is intensively researched as many stars have been found as members of binary systems. About half of Sun-like stars, and an even larger percentage of larger stars, form in multiple systems, and this can greatly influence phenomena such as novae and supernovae, the formation of certain types of stars, and the enrichment of space with nucleosynthesis products. [95] The influence of binary star evolution on the formation of massive evolved stars such as bright blue variables, Wolf-Rayet stars, and the progenitors of some classes of supernova core collapse is still disputed. Individual massive stars may not be able to expel their outer layers fast enough to form the types and numbers of evolved stars that are being observed, or to produce progenitors that will explode like the supernovae that are being observed. Mass transfer through stripping In binary systems is seen by some astronomers as the solution to that problem.[96][97][98] Distributing Artist's impression of the Sirius system, a white dwarf star orbiting a Type A main sequence star, stars are not uniformly distributed throughout the universe, but are normally clustered in galaxies along with gases. and interstellar dust. A typical large galaxy galaxy The Milky Way contains hundreds of billions of stars. There are more than 2 trillion galaxies (1012), although most is less than 10% of the mass of the Milky Way. [99] Overall, it is likely that there are between 1022 and 1024 stars [100] [101] (more stars of all sand grains on the planet earth). [102] [103] [104] Most of the stars are within galaxies, but between 10 and 50% of the starlight in large Galaxy clusters can come from stars outside of each galaxy. [105] [106] [107] A multi-star system is composed of two or more gravitant tied stars that orbit each other. The simplest and most common multi-star system is a binary star, but there are three or more star systems. For reasons of orbital stability, these multi-star systems are often organized in hierarchical series of binary stars [108]. The larger groups are called star clusters. These go from the loose star associations with just a few stars to open clusters with dozens to thousands of stars, up to huge globular clusters with hundreds of thousands of stars. These systems orbit their host galaxy. The stars in an open or globular cluster are all formed by the same giant molecular cloud, so all members normally agree and similar compositions. [83] Many stars are observed and most or everyone can be originally formed in gravitational-related multiple star systems. This is especially true for class or very massive b stars, 80% of which are believed to be part of multiple star systems. The percentage of single systems increases with the decrease in the stellar mass, so that only 25% of the red dwarfs is known to have stellar companions. At 85% of all the stars are red dwarfs, more than two-thirds of stars in the Milky Way, they are probably single red dwarfs. [109] In a 2017 study of Molecular Cloud Perseus, astronomers have discovered that most newly training stars are in binary systems. In the model that best explained the data, all the stars initially formed as binaries, although some binaries later divided themselves and leave individual stars behind. [110] [111] This vision of NGC 6397 includes stars known as blue barbags for their position on the Diagram of Russell Hertzsprung. The star closest to the Earth, apart from the sun, is proxima centauri, 4,2465 light years (40,175 trillioni kilometers away) away. Traveling in the orbital speed of the space shuttle, 8 kilometers per second (29,000 kilometers per hour), it would take about 150,000 to arrive. [112] This is typical of stellar separations in galactic disks. [113] The stars can be much closer to each other in the centers of galaxies and globular bunches, or much further in galactic halos. Due to the relatively vast distances between stars outside the Galactic, we think the collisions between stars are rare. In denser regions such as the nucleus of globular clusters or the galactic center, collisions can be more common. [114] Such collisions can produce what is known as blue buffs. These abnormal stars have a higher surface temperature and therefore are more blue than the stars at thebilling of the sequence in the cluster to which they belong; In standard stellar evolution, blue strapplers would have already evolved from the main sequence and thus would not have been seen in the cluster. [115] Characteristics almost everything about a star is determined by its initial mass, including such characteristics as brightness, size, evolution, life span and eventual fate. MAIN ARTICLE AGET: Stellar Age Estimation Most stars are between 1 billion and 10 billion years old. Some stars may even be close to 13.8 billion years" the observed age of the universe. The oldest star still discovered, HD 140 283, nicknamed Methuselah Star, is about 14.46 Â± 0.8 billion years old. [116] (Due to the uncertainty of the value, this age for the star does not conflict with the age of the universe, determined by the Planck satellite as 13,799 Â± 0.021). [116] [117]. The more massive the star, the shorter its life span, mainly because massive stars have more pressure on their nuclei, causing them to burn hydrogen faster. The largest stars last an average of a few million years, while the lowest mass stars (red dwarfs) burn their fuel very slowly and can last hundreds of billions of years. [118] [119]. [118] [119]. Lifetimes of Stages of Stellar Evolution in Billions of Years [120] Initial Mass (more â°) Main Sequence Subgiant First Red Giant Core Burn 1.0 9.33 2.57 0.76 0.13 1.6 2.28 0.03 0.12 0.13 2.0 2.2 0.03 0.12 0.13 2.0 1.20 0.01 0.02 0.28 5.0 0.10 0.0004 0.0003 0.02 chemical Composition See also: Metallicity and Molecules in Stars When stars form in the current Milky Way Galaxy, they are composed of about 71% hydrogen and 27% helium [121] measured by mass, with a small fraction of heavier elements. Typically, the portion of heavy elements is measured in terms of the iron content of the stellar atmosphere, since iron is a common element and its absorption lines are relatively easy to measure. The portion of heavier elements can be an indicator of the probability that the star has a planetary system. [122] The star with the lowest iron content ever measured is Dwarf HA1327-2326, with only 1/200,000 of the Sun's iron content. [123] In contrast, the super-rich star Leonis has almost doubled the abundance of iron as the sun, while the star of planet 14 Herculis has almost tripled the iron. [124] Chemically peculiar stars show unusual abundances of certain elements in their spectrum; Especially the elements of chrome and rare earth. [125] Stars with colder external atmospheres, including the sun, can form various diatomic and polyatomic molecules. [126] Diameter Main articles: List of the largest stars, list of the smallest stars and the Solar some of the famous stars with their appearing colors and their sizes thanks to their great distance from the earth, all the stars except the sun seem to the eye without help as shining points in the night sky that shine because of the effect of the atmosphere terrestrial. The sun is close enough to the earth to look like a disc instead, instead, To provide daylight. Apart from the sun, the star with the largest apparent dimension is R Dorado, with a corner diameter of only 0.057 Arcsecondi. [127] The discs of most stars are too small in angular dimensions to be observed with current optical telescopes based on the ground, so interferometric telescopes are needed to produce images of these objects. Another technique to measure the angular dimensions of the stars is through the occultation. Accurately measuring the decline in a star's brightness as it is occult from the moon (or from the increase in the brightness when reappears), the angular diameter of the star can be calculated [128]. The stars vary in size from neutron stars, which vary anywhere from 20 to 40 km (25 mi) in diameter, to Supergians as betelgeuse in the constellation of Orion, which has a diameter about 1,000 times that of the sun [129] [130] With a much lower density. [131] Kinematic main article: Stellar Kinematics The Pleiades, an open cluster of stars in the Taurus constellation. These stars share a common movement through space. [132] The movement of a star relative to the sun can provide useful information on the origin and the east of a star, as well as the structure and evolution of the surrounding galaxy. The components of the movement of a star consist of radial speed to or away from the sun, and the angular movement crossed, which is called its correct movement. The radial speed is measured by the movement of the Doppler of the spectral lines of the star and is supplied in km / s unit. The correct movement of a star, its parallax, is determined by precise astrometric measurements in millstroke centers seconds (MAS) a year. With the knowledge of the star parallax and its distance, it is possible to calculate the correct speed of movement. Together with radial speed, the total speed can be calculated. The stars with high proper motion rates are probably relatively close to the sun, making them good candidates for parallax measurements. [133] When both motion rates are known, the speed of the star space relative to the sun or the galaxy can be calculated. Among the nearby stars, it was found that the youngest population that stars generally speeds lower than the oldest stars, Population II. The latter have elliptical orbit who are prone to the plane of the galaxy. [134] A comparison between the kinematics of the nearby stars allowed astronomers to trace their origin to common points in giant molecular clouds and are indicated as stellar associations. [135] Main field of magnetic field: Stellar magnetic field magnetic field Magnetic field of SuÃ ¢ Aur (a young tau type star), rebuilt using Zeeman - Doppler Imaging the field of a star is generated within the regions of the interior where convective circulation occurs. This conductive plasma motion works like a dynamo, in which the motion of electric charges induce magnetic fields, as does a mechanical dynamo. Those magnetic fields have a wide range that extend all over and beyond the star. The intensity of the magnetic field varies with the mass and composition of the star, and the amount of surface magnetic activity depends on the rotational speed of the star. This surface activity produces stellar spots, which are regions with strong magnetic fields and below-normal surface temperatures. Coronal loops are flux lines of the magnetic field that rise from the surface of a star into the outer atmosphere of the star, its corona. Coronal cycles can be seen because of plasma leading along their length. Stellar flares are explosions of high-energy particles emitted by the same magnetic activity.[136] Young, fast-rotating stars tend to have high levels of surface activity due to their magnetic field. The magnetic field can act on the stellar wind of a star, acting as a brake to gradually slow down the rotation speed over time. Therefore, older stars such as the Sun have a much slower rotation speed and a lower level of surface activity. The activity levels of slow-rotating stars tend to vary cyclically and can stop completely for periods of time.[137] During the Maunder Minimum, for example, the Sun underwent a 70-year period with almost no sunspot activity.[138] Mass Main article: Stellar mass One of the largest stars in the world. known is the Eta Carinae,[139] which, with a mass 100"150 times greater than that of the Sun, will have a lifespan of a few million years. Studies of the largest open clusters suggest 150 MÃ¢Â¡Â¡ as an approximate upper limit for stars in the current universe age.[140] This represents an empirical value for the theoretical limit of the mass of stars forming due to the increase in radiation pressure on the rising gas cloud. Some stars in the R136 cluster in the Large Magellanic Cloud have been measured with higher masses,[141] but it has been determined that they may have been created by the collision and fusion of massive stars in nearby binary systems, bypassing the 150 MÃ¢Â¡Â¡ limit of massive star formation.[142] The nebula Reflective NGC 1999 is brilliantly illuminated by the V380 Orionis. The black sky spot is a vast hole of empty space and not a dark nebula as previously thought. The first stars to form after the Big Bang may have been larger, up to 300 MÃ¢Â¡,[143] due to the complete absence of heavier lithium elements in their composition. This generation of supermassive III stars probably existed in the early Universe (i.e. they are seen to have a high redshift) and may have started the production of chemicals heavier than hydrogen, needed for the subsequent formation of planets and life. In June 2015, astronomers reported evidence of the presence of Population III stars in the Cosmos Redshift Galaxy 7 at z = 6.60.[144][145] With a mass of only 80 times that of Jupiter (MJ), 2MASS J0523-1403 is the smallest known nuclear fusion star in its core.[146] For stars with a Sun-like metallicity, the theoretical minimum mass that the star can have and subpoenaed to the fusion to the core, it is estimated that it is about 75 MJ.[147][148] When metallicity is very low, the minimum star size seems to be about 8.3% of the solar mass, or about 87 MJ.[148][149] The smaller bodies called brown dwarfs occupy a grey area poorly defined among stars and gas giants.[147][148] The combination of the radius and the mass of a star determines its surface gravity. The giant stars have a superficial gravity much lower than the stars of the main sequence, while the opposite is the case of degenerated and compact stars like white dwarfs. Surface gravity can affect the appearance of a star's spectrum, with greater gravity causing an expansion of absorption lines. [33] Rotation Main article: stellar rotation The rotation rate of the stars can be determined by the spectroscopic measure, or more precisely determined by the tracking of their stellar spots. The young stars can have a rotation of more than 100 km/s to the equator. The star of the class B Achernar, for example, has an equatorial velocity of about 225 km/s or greater, causing its equator to lean outwards and giving it an equatorial diameter greater than 50% compared to the poles. This rotation rate is just below the critical speed of 300 km/s, at which the speed of the star would break.[150] On the contrary, the Sun rotates once every 25–35 days depending on latitude,[151] with an equatorial speed of 1.93 km/s.[152] A magnetic field of the main sequence star and the star wind serve to slow its rotation from a significant amount that evolves on the main sequence. [153] The degenerate stars have contracted in a compact mass, with a rapid rate of rotation. However, they have relatively low rotation rates compared to what would be expected from the conservation of the angle moment — the tendency of a rotating body to compensate for a contraction in size by increasing its rotation rate. A large part of the angular moment of the star is dissipated due to the mass loss through the stellar wind.[154] Despite this, the rotation rate for a pulsar can be very fast. The pulsar in the heart of the crab nebula, for example, rotates 30 times a second. [155] The rate of rotation of the pulsar will gradually rise due to radiation emission. [156] Temperature The surface temperature of a main sequence star is determined by the energy production rate of its core and radius, and is often estimated by the star color index.[157] The temperature is normally given in terms of an effective temperature, which is the temperature of an idealized black body that radiates its energy to the same brightness by the surface of the star. The actual temperature is onlyof the surface, as the temperature increases towards the nucleus.[158] The temperature in the central region of a star is several million kelvins. [159] Star temperature will determine the rate of ionization of various elements, resulting in characteristics of absorption lines in the spectrum. The surface areaOf a star, along with its characteristics of magnitude and absolute visual absorption, it is used to classify a star (see the classification below). [33] The stars of the massive main sequence can have surface temperatures of 50,000 K. Smaller stars as the sun have superficial temperatures of a few thousand K. The red giants have relatively low surface temperatures of about 3,600 K; But they have a high brightness due to their large external surface. [160] Radiation The energy produced by the stars, a nuclear fusion product, radiates into space as an electromagnetic radiation and particle radiation. The radiation of particles emitted by a star manifests itself as the stellar wind, [161] which flows from the external layers as electrically loaded protons and alpha and beta particles. A constant stream of neutrinos almost without mass emanates directly from the star core. [162] The production of energy in the center is the reason why the stars shine so brightly: every time two or more atomic nuclei blend together to form a single atomic core of a new heavier element, gamma-ray photons are released from Nuclear fusion product. This energy is converted into other forms of electromagnetic energy of lower frequency, such as visible light, at the time when reaching the outer layers of the star. [163] The color of a star, as determined by the most intense frequency of the visible light, depends on the temperature of the outer layers of the star, including its photosphere. [164] In addition to visible light, the stars emit forms of electromagnetic radiation that are invisible to the human eye. In fact, the stellar electromagnetic radiation embraces the entire electromagnetic spectrum, from the wavelengths longer than the radio waves through the infrared, the visible light, the ultraviolet, to X-rays and gamma rays. From the point of view of the total energy emitted by a star, not all the components of the stellar electromagnetic radiation are significant, but all frequencies provide a vision of the physics of the star. [162] Using the stellar spectrum, astronomers can determine the surface temperature, superficial gravity, metallization and rotation speed of a star. If you find the distance of the star, as measuring the parallax, you can get the light's brightness. Mass, radius, superficial gravity and rotation period can be evaluated based on stellar models. (The mass can be calculated for the stars in binary systems by measuring orbital speeds and distances. The gravitational microlysing was used to measure the mass of a single star. [165] With these parameters, astronomers can estimate the age of the star. [166] The brightness of a star is the quantity of light and of radiant energy forms radiating per unit of time. He has power units. The brightness of a star is determined by its radius and surface temperature. Many stars do not radiate evenly on their entire surface. The star in fast rotation Vega, for example, has a higher energy flow (power per unit area) to its poles that along itsSpots on the star's surface with a lower than average temperature and brightness are known as stellar spots. Small dwarf stars like our Sun generally have discs devoid of features with only small star spots. Giant stars have much larger, more obvious star spots,[168] and show strong darkening of the stellar limbs. That is, the brightness decreases towards the edge of the stellar disc. [169] Dwarf red flare stars such as UV Ceti may have the characteristics of prominent stars. [170] Magnitude Main articles: apparent magnitude and absolute magnitude The apparent luminosity of a star is expressed in terms of its apparent magnitude. It is a function of the brightness of the star, its distance from the Earth, the extinction effect of interstellar dust and gas, and the alteration of the star's light as it passes through the Earth's atmosphere. The intrinsic or absolute magnitude is directly related to the brightness of a star, and is the apparent magnitude that a star would be if the distance between the Earth and the star were 10 parsecs (32.6 light years).[171] Number of stars brighter than the apparent magnitude Number of stars[172] 0 4 15 2 48 3 17 1 4 513 5 1,6024 4,800 7 1 Both the apparent and absolute magnitudes are logarithmic units: a difference in the total number of magnitudes equals a change in brightness of about 2.5 times[173] (the 5th root of 100 or about 2.512). This means that a first star of magnitude (+1.00) is about 2.5 times brighter than a second magnitude (+2.00), and about 100 times brighter than a sixth magnitude star (+6.00). The most visible stars to the naked eye in good viewing conditions are magnitudes +6.[174] On both apparent and absolute magnitudes, the smaller the number of magnitudes, the greater the star; the greater the number of magnitudes, the fainter of the star. The brightest stars, on both scales, have negative magnitude numbers. The change in brightness (ÎL) between two stars is calculated by subtracting the size number of the brightest star (mb) from the size number of the fainter star (mf), then using the difference as exponent for the base number 2,512; i.e.: Î m f â ¢ m b {\displaystyle \Delta {m}=m_{\mathrm {f} }-m_{\mathrm {b} }} 2.512 Î m = Î L {\displaystyle 2.512^{\Delta {m}}=\Delta {L}} The absolute magnitude of a star (M) and the apparent magnitude (m) are not equivalent;[173] for example, the luminous star Sirius has an apparent magnitude of 1.44, but has an absolute magnitude of +1.41. The Sun has an apparent magnitude of 26.7, but its absolute magnitude is only +4.83. Sirius, the brightest star in the night sky as seen from Earth, is about 23 times brighter than the Sun, while Canopus, the second star of the Sun, is the second star. night sky light with an absolute magnitude of −5.53, is about 14,000 times brighter than the Sun. Sun.The brighter of the two. This is because Sirio is only 8.6 years old from the earth, while Canopo is much further away, at a distance of 310 light years [175]. The most bright stars have absolute magnitudes of about 12 million times the brightness of the sun. [176] Theoretically, the least luminous stars are at the lower ground limit to which the stars are able to support the nuclear fusion of hydrogen in the nucleus; The stars just above this limit are located in the cluster NGC 6397. The weaker red dwarf of the cluster are of absolute magnitude 15, while a white dwarf of 17th absolute magnitude was discovered. [177] [178] Classification Main article: Stellar classification Surface temperature ranges for different stellar classes [179] Star or 33,000 sample temperature class, KÃ, OrÃ, Più Zeta Ophiuchi b 10,500Ã ¢ â ¢ 30,000 K Rigel at 7,500 Â «10,000ã, K Altair f 6,000 Â «7,200Ã, K Procyonã, AG 5,500 Â« 6,000ã, K Sole K 4,000 Â «5.250ã, K ESPSILON THENE M 2,600 Â« 3.850Ã, K Proxima Centauri The current star classification system dates back to Starts of the 20th century, when the stars were classified by A to Q based on the intensity of the hydrogen line. [180] It was thought that the intensity of the hydrogen line was a simple linear function of the temperature. Instead, it was more complicated: it was strengthened with the increase in temperature, reached a peak near the 9000Ã, k, and then decreasing at greater temperatures. The classifications were then reordered based on the temperature, on which the modern scheme is based. [181] The stars are classified in a single letter according to their spectra, ranging from the type or, very hot, to M, so cold that molecules can form in their atmospheres. The main classifications in decreasing order of surface temperature are: O, B, A, F, G, K and M. A variety of rare spectral types are classified in a special way. The most common are the guys L and T, which classify the lowest heavier mass stars and the brunettes. Each letter has 10 subdivisions, numbered from 0 to 9, in descending order of temperature. However, this system breaks at extremely high temperatures, since O0 and O1 classes may not exist. [182] Furthermore, the stars can be classified according to the effects of brightness present in their spectral lines, which correspond to their spatial dimensions and are determined by superficial gravity. These range from 0 (hypergigant) to III (giants) to V (nane of the main sequence); Some authors add VII (white dwarfs). The stars of the main sequence fall along a narrow diagonal band when they are drawn according to their absolute magnitude and their spectral type. [182] The sun is a yellow dwarf of the main intermediate temperature g2V sequence and normal dimensions. [183] There is an additional nomenclature in the form of lowercase letters added at the end of the type To indicate the peculiar characteristics of the spectrum. For example, one «is» can indicate the presence of emission lines; Â «Mâ €» represents unusually high levels of metals, and Â «Varâ» can indicate variations in the in the type. [182] The white dwarf stars have their own class beginning with the letter D. This is further divided into the DA, DB, DC, DO, DZ and DQ classes, depending on the types of prominent lines present in the spectrum. This is followed by a numerical value indicating the temperature.[184] Variable Stars Main article: Variable Star The asymmetric aspect of Mira, a variable oscillating star Variable stars have periodic or random variations of brightness due to intrinsic or extrinsic properties. Of the intrinsically variable stars, the primary types can be divided into three main groups. During their stellar evolution, some stars go through stages in which they can become variable buttons. The variable stars buttons vary in radius and brightness over time, expanding and contrasting with periods ranging from minutes to years, depending on the size of the star. This category includes cefeid and cefeid stars, and long-term variables such as Mira.[185] The eruptive variables are stars that undergo sudden increases in brightness due to shine or mass expulsion events.[185] This group includes the protostelles, the Wolf-Rayet stars, and the starling stars, as well as the giant and supergiant stars. The variable cataclysmic or explosive stars are those that undergo a dramatic change in their properties. This group includes novae and supernovae. A binary star system that includes a nearby white dwarf can produce some types of these spectacular stellar explosions, including the nova and a Type 1a supernova. The explosion is created when the white dwarf accumulates hydrogen from the star, accumulating mass until the hydrogen is melting.[186] Some novae are recurring, with periodic explosions of moderate amplitude.[185] Stars may vary in brightness due to extrinsic factors, such as eclipse tracks, as well as rotating stars that produce extreme stains.[185] A remarkable example of eclipse is the Algol, which regularly varies with magnitude from 2.1 to 3.4 for a period of 2.87 days.[187] Main article structure: Star structure Internal structures of stars of the main sequence with masses indicated in solar masses, convective zones with arrowed cycles and radiative zones with red flashes. From left to right, a red dwarf, a yellow dwarf and a star of the main blue-white sequence The interior of a stable star is in a state of hydrostatic balance: the forces of any small volume almost counterbalance each other. The balanced forces are the internal gravitational force and an external force due to the pressure gradient inside the star. The pressure gradient is determined by the temperature gradient of the plasma; the outer part of the star is colder than the nucleus. The temperature at the center of a sequenceor of a giant star is at least the order of 107 K. The temperature and pressure resulting in the nucleus that burns the hydrogen of a star of the main sequence are sufficient for nuclear fusion and for energy production enough for Further collapse of the star. [188] [189] While atomic nuclei are fused into the nucleus, they emit energy in the form of gamma rays. These photons interact with the surrounding plasma, adding thermal energy to the center. The stars on the main sequence convert hydrogen into helium, creating a slowly but steadily increasing proportion of helium in the nucleus. Eventually the helium content becomes predominant and the energy production ceases in the center. Instead, for stars larger than 0.4 m â°, fusion takes place in a slowly expanding shell around the degenerated helium nucleus. [190] In addition to hydrostatic equilibrium, the interior of a stable star will maintain an energetic equilibrium of thermal equilibrium. There is a radial temperature gradient throughout the interior which results in a flow of energy flowing outwards. The extroverted flow of energy leaving any strata inside the star will correspond exactly to the inflow from below. [191] The radiation zone is the region of the stellar interior where the external energy flow depends on the transfer of radiative heat, as the transfer of convective heat is inefficient in that zone. In this region the plasma will not be disturbed, and any mass movement will die. If this is not the case, the plasma becomes unstable and convection will occur, forming a convection zone. This can occur, for example, in regions where very high energy flows occur, for example near the core or in areas with high opacity (performing inefficient radiative heat transfer) such as in the outer envelope. [189]. The occurrence of convection in the outer envelope of a main sequence of the star depends on the mass of the star. Stars with several times the mass of the sun has a deep convection zone inside and a radiative zone in the outer layers. Smaller stars like the sun are exactly the opposite, with the convective zone located in the outer layers. [192] Red dwarf stars with less than 0.4 m â° are convective throughout, which prevents the accumulation of a helium nucleus. [79] For most stars the convective zones will vary over time while the stellar patterns and interior constitution are modified. [189] A cross section of the Sun, the Photo Photo is that portion of a star that is visible to an observer. This is the layer where the star's plasma becomes transparent to photons of light. From here, the energy generated at the center becomes free to propagate through space. It is within the PhotoSphere that the sunspots, regions of below-average temperature, appear. [193] Above the level of the PhotoSphere is the stellar atmosphere. In a main sequence star like the Sun, the lowest level of the atmosphere, just above the PhotoSphere, is the thin region of the chromosphere, where the stars appear. And the star rockets begin. Above this is the transition region, where the temperature increases quickly within a distance of only 100 km (62 ml). Beyond this is the crown, a super-heated volume of plasma that can extend outwards to several miles. [194] The IL Of a crown seems to depend on a convective area in the outer layers of the star. [192] Despite its high temperature, and the crown emits very little light, due to its low gas density. The crown region of the sun is normally visible only during a solar eclipse. From the crown, a stellar wind of plasma particles expands outwards from the star, until it interacts with the interstellar means. For the sun, the influence of its solar wind extends into a bubble-shaped region called heliosphere. [195] Main article: Stellar nucleosynthesis Overview of the proton-protoneThe carbon-nitrogen-oxygen cycle When the nuclei merge, the mass of the molten product is less than the mass of the original parts. This lost mass is converted into electromagnetic energy, according to the ratio of mass-energy equivalence and = MC2. [196] A variety of nuclear fusion reactions takes place in the nuclei of the stars, which depend on their mass and composition. The hydrogen fusion process is sensitive to temperature, therefore a moderate increase in the temperature of the nucleus will cause a significant increase in the fusion rate. As a result, the central temperature of the stars of the main sequence varies from 4 million Kelvin for a small class M star at 40 million kelvin for a classy or massive star. [159] In the sun, with a core of 16 million kelvin, hydrogen blends to form helium in the reaction of the proton-proton chain: [197] 41h â † '22h + 2e + + 2Î½E (2 x 0.4 MEV) 2e + + 2Eâ 'â †' 2Î³ (2 x 1.0 MEV) 21h + 22h â † '23hE + 2Î³ (2 x 5.5 MEV) 23hev) 23he â †' 4he There are a couple of other paths, in which 3he and 4he combine to form 7bs, which eventually (with the addition of another proton) produces two 4he, a gain of one. All these reactions are in the overall reaction: 41h â † '4he + 2Î³ + 2Î½E (26.7 MEV) where Î³ is a photon gamma rays, / and is a neutrino, and H and he are hydrogen isotopes and helium, respectively. The energy released by this reaction is in millions of electron volts. Every individual reaction produces only a small amount of energy, but because a huge number of these reactions occur constantly, produce all the energy needed to support the star radiation output. In comparison, the combustion of two hydrogen gas molecules with a oxygen gas molecule releases only 5.7 EV. In more massive stars, helium is produced in a cycle of carbon catalyzed reactions called carbon-nitrogen-oxygen cycle. [197] In advanced stars with 100 million kelvin nuclei and masses between 0.5 and 10 mâ € ‰, helium can be transformed into carbon in the triple-alpha process that uses the beryllium of the intermediate element: [197] 4he + 4he + 92 Kev â †' '8 * BE 4 for an overall reaction of: Overview of consecutive processes in mass stars 34he â †' 12C + Î³ + 7.2 MEV in the stars of heavier elements can be burned in a contracting core through the process of neon burning and oxygen combustionThe final stage of the stellar nucleosynthesis process is the combustion process of silicon that leads to the production of the stable iron-56 isotope.[197] Any further fusion would be an endothermic process that consumes energy, and therefore further energy can be produced only through gravitational collapse. Duration of the main phases of fusion for a star of 20Â MâÂ¡[198] Fuel temperature (millions of kelvin) Density (kg/cm3) Burn time (in years) H 37 0,0045 8,1Â million He 188 0,97 1.2Â million C 870 170 976 Ne 1.570 3.100 0,6 O 1.980 5.550 1,25

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Excerpt from Â" 2Binary star in the constellation Cygnus 61 Cygni Location of 61 Cygni Observation data Epoch J2000.0Â¨ Â¨ Â¨ Equinox J2000.0 Constellation of Cygnus 61 Cygni A Right Ascension 21h 06m 53.940s[1] Declination +38 Ã¨Â°°°°°°°°°°°°°°°°°°°°°° ° 61 Cyg A Spectral type K5V[1] Colour index UÃ¢Â¤B +1.155[3] Colour index BÃ¢Â¤V +1.139[3] Variable type BY Dra[4] 61 Cyg B Spectral type K7V Colour index BÃ¢Â¤V +1.242[3] Variable type Flare Star[3] 5] Astrometry61 Cy ARadial velocity (Rv) -65.94[6]e km/proprio motorcycle (Ã1â4) RA:Ã© 4164.174[6]e mas/year Dec.:Ã© 3249.991[6]e mas/year Parallasse (Ã) 285.9949e mas/year 0.0599[7]moreDistance11.404 to 0.002 Ã ly (3.4966 to Ã± 0.0007Ã¨ pc) absolute magnitude (MV) 7,506[8]61 Cygni BRadial velocity (Rv) -64.43[9]Ã¨ km/sOwn motion (Ã©1â) 4) RA:Ã© 4,105,786[9]Ã¤ mas/year Dec.:Ã¤ 3,155,759[9]Ã¤ mas/yr Parallasse (Ã) 286.0054Ã¤± 0,0289[10]Ã¤ masDistanza11,404 ¤ ± 0.001 ¤ ly (3.4964 ¤± 0.0004 ¤ p (c) absolute magnitude (MV) 8,228[8] Orbit[11]Companion61 Cygni BPeriod (P) 678 ±34 yrSemi-major (a) 24,272 ±0.592 ±3Eccentricity (e) 0.49 ±0.03inclination (i) 51 ± Length of the node (Ã©) 178Ã±2Ã¨Â°Periatronic age (T) 1709 Ã¨±16Periastron topic (Ã¡Ã¡) (secondary) 149 Ã¨Ã±6Ã¨Â° Details61 Cygni AMass0.70[12]Ã© Maximum radius 0.665 to 0.005[13]to Raggio Luminosity 0.153 to 0.01[13]to Surface Gravity (Logue g) 4.40[14]to cgsTemperature4.52 6 to 66[15]to KMetallicity [Fe/H]Ã¢0.20[14] dexRotation35.37 d[16]Summer 6.1 ±1[13] BMass swans0.63[12]to Massimoraggio0.595 to 0.008[13]to Radiation0.0 85 to 0.007[13]to Surface gravity (logue g) 4.20[14]Ã¨ cgsTemperature4.077 cgsTemperature4.077 cgsTemperature4.077 [Fe/H]â0.27[14] dexRotation37.84 d[16]Age6.1 Ã±1[13] Gyr Other denominations GJ 820 A/B, Struve 2758, ADS 14 636, V1803 Cygni, GCTP 5077.00[17] 61 Cygni A: V180 319 Cygni, HD 201 091, HIP 104 214, HR 8085 SIMBUN The AB 61 Cygni system is a binary star system in the constellation Cygnus, consisting of a pair of K-type dwarf stars orbiting each other over a period of about 659 years. Apparent magnitudes 5.20 and 6.05, respectively, can be seen with binoculars in city skies or with the naked eye in rural areas without photopollution. 61 Cygni first attracted the attention of astronomers when his great correct motion was demonstrated by Giuseppe Piazzi in 1804. In 1838, Friedrich Bessel measured its distance from Earth at about 10.4 light-years, very close to the actual value of about 11.4 light-years; this was the estimate of the first distance for any star other than the Sun, and the first star to have its stellar parallax measured. Of all the stars or star systems listed in the modern Hipparcos catalog, 61 Cygni has the seventh highest correct motion, and the highest of all visible stars or systems.[note 1][18][19] Throughout the 20th century, several astronomers have reported evidence of a massive planet orbiting one of the two stars, but recent observations have been made. High-precision radial velocity statements have shown that all these claims were unfounded. [20] No planets have been confirmed in this star system to date. The name 61 Cygni is relatively dim, so it does not appear on ancient star maps, nor is it given a name in Western[21] or Chinese systems. [22] The name "61 Cygni" is part of the Flamsteed designation given to the stars. According to this designation scheme, devised by John Flamsteed to catalogue his observations, the stars of a particular constellation are numbered in the order of their correct ascension, not in Greek letters such as Bayer's designation.[23][24] The star does not appear under that name in Flamsteed's Historia Coelestis Britannica,[25] although he has stated that he called 61 Cygni, it actually corresponds to what he called 85 Cygni in the 1712 edition. [26] It was also called the "Star of Bessel" or "Flying Star of Piazzi"[27][28] History of the Observation The first well-recorded observation of the stellar system with optical instruments was made by James Bradley on September 25, 1753, when he noticed that it was a double star. William Herschel began systematic observations of 61 Cygni as part of a larger study of binary stars. His observations led to the conclusion that the binary stars were separated enough to show different movements as they orbit each other. In 1792, Piazzi noticed the high correct motion displacement from our point of view) at intervals of a of the 21st century. In 1792, Piazzi noticed the high correct motion when he compared his observations of 61 Cygni with those of Bradley, made 40 years earlier. This led to considerable interest in 61 Cygni by contemporary astronomers and its observation has continued since that date. [29] Piazzi's repeated measurements led to a definitive value of his motion, which he published in 1804. [30] [31] He was on this record, he christened the system "Flying Star." [32] Piazzi observed that this motion meant that it was probably one of the closest stars, and suggested that it would be a prime candidate for an attempt to determine its distance through parallax measurements, along with two other possibilities, delta Eridani and Mu Cassiopeiae. [31] Parallax measurement A number of astronomers early took up the task, including the attempts of FranÃ§ois Arago and Claude-Louis Mathieu in 1812, who recorded the Parallasse, and so as Friedrich Georg Wilhelm Von Struglio pointed out after his series of tests between 1818 and 1821, all these numbers are more accurate than the accuracy of the instrument used. [29] Friedrich Wilhelm Bessel made a notable contribution in 1812 when he used a different method of measuring the distance. Assuming the orbital period of the two stars in the binary to be 400 years old, he estimated the distance between the two would require and then measured the angular distance between the stars. This led to a value of 460 mas. He then followed with direct measurements of parallax in a series of observations between 1815 and 1816, comparing it with six other stars. The two sets of measurements produce values of 760 and 1320 mas. All these estimates, like previous attempts by others, contained greater inaccuracies than measurements. [29] When Joseph Von Fraunhofer invented a new type of heliometer, BESSEL made another set of measurements using this device in 1837 and 1838 in KÃ¶nigsberg. He published his results in 1838 [33] with a value of 369.0 Ã± 19.1.30 at And 260.5 Ã± 18.8 at B and estimated the center point to be 313.6 Ã± 13.6. This corresponds to a distance of about 600,000 astronomical units or about 10.4 light years. This was the first direct and reliable measurement of the distance from a star other than the Sun. [29] [5] His measurement was published shortly before similar measurements of Vega parallax by Friedrich Georg Wilhelm von Struve and Alpha Centauri by Thomas Henderson that same year. [36] BESSEL continued make further measurements at Königsberg, publishing a total of four complete observation rounds, the last in 1868. The best of these has placed the central point at 360,2 ± 12,17, 12,17,during the observations in 1849.[29] This is near the currently accepted value of 287.18 mas (which lasts 11.36 light years). [37] Only a few years after Bessel's measure, in 1842 Friedrich Wilhelm Argelander noted that Groombridge 1830 had an even greater appropriate movement, and 61 Cygni became the second most well known. He was later moved forward to the list by Kapteyn's star and Barnard's star. [6] 61 Cygni has the seventh highest right movement of all star systems listed in the modern Hipparcos catalogue, but maintains the highest correct movement title among the stars visible to the naked eye. [18] Binary remarks Due to the wide angular separation between the 61 Cygni A and B, and the correspondingly slow orbital movement, it was initially unclear whether the two stars of the 61 Cygni system were a gravitational system or simply a juxtaposition of the stars.[38] von Struve argued for its binary status in 1830, but the issue remained open. [38] However, in 1917, measured parallax differences showed that separation was significantly lower. [39] The binary nature of this system was clear by 1934, and the orbital elements were published. [40] In 1911, Benjamin Boss published the data indicating that the 61 Cygni system was a member of a group of stars. [41] This group containing 61 Cygni was subsequently expanded to include 26 potential members. Possible members include Beta Columbae, Pi Mensae, 14 Tauri and 68 Virginis. The spatial velocities of this group of stars range from 105 to 114 km/s compared to the Sun.[42][43] The observations made by the planet's research programs show that both components have strong linear trends in radial speed measurements. [44] Amateur observation An observer using 7×50 binoculars can find 61 Cygni two binocular fields south-east of the light star Deneb. The angular separation of the two stars is slightly greater than the angular dimension of Saturn (16-20"). [45] Thus, under ideal vision conditions, the binary system can be solved by a telescope with a 7 mm aperture. 2) This is well within the opening capacity of the typical binoculars, although to solve the track they need a constant assembly and some 10x magnification. With a separation of 28 arc-seconds between the stars of the components, the 10× magnification would give an apparent separation of 280 arc-seconds, over the eye resolution limit generally considered to be 4 minutes arc or 240 seconds arc. [46] Property Although it seems to be a star pair with a naked eye, 61 Cygni is a widely separated binary star system, consisting of two main sequence stars of class K (orange), the brightest 61 Cygni A and dimmer 61 Cygni B, which have apparent magnitudes of 5.2 and 6.1, respectively. They seem to be old stars, [47] [48] with an esteemed oue that is older than the Sun. At a distance of just more than 11 years light, it is the sixteenth system of 15 Å ª -nearest known For the earth (not understood). 61 Swans A is the fourth star of hospitalization that is visible naked for the northern mid-latitude observers, after Sirius, Epsilon Eridani and Procyon A.[12] This system will make its closest approach to about 20,000 CE, when the separation from the Sun will be about 9 light years. Smaller and dimmer than the Sun, 61 Cygni A has about 70 percent of a solar mass, 72 percent of its diameter and about 8.5 percent of its luminosity and 61 Cygni B has about 63 percent of a solar mass, 67 percent of its diameter, and 3.9 percent of its luminosity. The long-term stability of 4 led to it being selected as an "acre star" in the Morgan-Keenan (MK) classification system in 1943, serving as the "acre point" of K5 V ever since. [50] Beginning in 1953, 61 Cygni B was considered a standard K7 V star (Johnson & Morgan 1953,[51] Keenan & McNeil 1989[52]). Comparison between the Sun (left), 61 Cygni A (left) and 61 Cygni B (left). 61 Cygni A is a variable star named as V1803 Cyg while 61 Cygni B is a flare variable star named HD 201 092 with their designated values of 5.21 V and 6.03, respectively. [53] The two stars orbit their common center of gravity over a period of 659 years, with a separation between them, averaging of about 84 AUâ84 times the separation between the Earth and the Sun. The relatively large orbital eccentricity of 0.48 means that the two stars are separated by about 44 AU at periapsis and 124 AU at apoapsis. 3] The pleasant orbit of the pair has made it difficult to bait the respective masses, and the accuracy of these values remains somewhat controversial. In the future, this problem can be solved through the use of asteroseismology [13] 61 Cygni A has about 11% more than 61 Cygni B.[12] The system has a cycle of activity that is much more pronounced than the solar cycle of the solar point. It is a complex cycle of activity that varies with a period of about 7.5Ã±1.7 years.[54][55] The activity of the stellar point combined with rotation and chromospheric activity is a feature of a Draconis BY variable. Due to differential rotation, the surface rotation period of this star varies from 27 to 45 days, with an average period of 35 days. [56] The orbital motion of Component B relative to Component A as seen from Earth and the true aspect from face-to-face view. The time steps are about 10 years. The outflow of the stellar wind from component A produces a bubble within the local interstellar cloud. Along the direction of the star's motion within the Milky Way, it extends to a distance of only 30 AU, or roughly the orbital distance of Neptune from the Sun. This is less than the separation between the two components of 61 Cygni, and thus the two most likely do not share a common atmosphere. The compactness of the astrosphere is probably due to the low mass outflow and the relatively high velocity through the medium. Local. b shows a more chaotic model of variability than, with remarkable short-term flares. there is a 11.7 year yearB.[55] Both stars exhibit the activity of star flare, but the B chromosphere is 25% more active than 61 Cygni A.[57] As a result of differential rotation, the rotation period ranges from 32 to 47 days, with an average period of 38 days. [16] There is some disagreement on the evolutionary age of this system. The cinematic data provide an estimate of the age of about 10 Gyr. Gyrochronology, or the determination of the age of a star based on its rotation and color, results in an average age of 2.0 ±0.2 Gyr. The chromospheric age for A and B is 2,36 Gyr and 3.75 Gyr respectively. Finally, the estimates of the era using the isocron method, which involve adaptation of stars to evolutionary models, produce higher limits of 0.44 Gyr and 0.68 Gyr.[58] However, a 2008 evolutionary model that uses the CESAM2k code from the Côte d'Azur Observatory provides an estimate of the age of 6,0 ±1.0 Gyr for the couple. [13] Promise of a planetary system On several occasions, it was stated that 61 Cygni might have unseen lesser companions, planets or brown dwarf. Kaj Strand of the Sproul Observatory, under the direction of Peter van de Kamp, made the first claim in 1942 using observations to detect small but systematic variations in the orbital movements of 61 Cygni A and B. These disturbances suggested that a third body of about 16 masses of Jupiter should orbit around 61 Cygni A.[59] Reports of this third body served as an inspiration for Hal Clement's science fiction novel of 1953 Mission of Gravity. [60] In 1957, van de Kamp narrowed his uncertainties, claiming that the object had a mass of eight times that of Jupiter, an orbital period of 4.8 years, and a semi-major axis of 2.4 AU, where 1 AU is the average distance from Earth to the Sun.[61] In 1977, Soviet astronomers at the Pulkovo Observatory near St. Petersburg suggested that the system included three planets: two giant planets with six and twelve masses of Jupiter around 61 Cyg A,[62] and a giant planet with seven masses of Jupiter around 61 Cyg B.[63] In 1978, Wulff-Dieter Heintz of mass Sproul Observatory showed that these statements were also spurious, as they were unable to detect any evidence of seeing the motion data of 2018. These combined abnormalities are indicative of the possible presence of a third perturban object in orbit around 61 Cygni B. [66] The living area for 61 Cygni A, defined as the locations where liquid water could be present on an planet similar to Earth, is 0.26–0.58 AU. For 61 Cygni B, the living area is 0.24–0.50 AU.[67] There's one on.the team of the Observatory mcdonald has established limits to the presence of one or more planets around 61 cygni a and 61 cygni b with masses between 0.07 and 2.1A masses of jupiter and medium separations between 0.05 and 5.2Â UA.[68] due to the proximity of this system to the sun, is often a target of interest for astronomers. Both stars were selected by the nasa as targets of "Tier 1" for the mission of space interferometry.[69] this mission is potentially able to detect planets with a mass of 3" times the mass of the earth at an orbital distance of 2â ua from the star. the measurements of this system seem to have detected an excess of infrared radiation, higher than that emitted by the stars. This excess is sometimes associated with a dust record, but in this case it is located sufficiently close to one or both stars to have not been resolved with a telescope.[70] a study conducted in 2011 using the interferometer keck nuller did not detect any exozodiacal dust around 61 cygni A.[71] project for research on biosignature the two stars are among the five paradigms (all close stars) from the vision of the star research project of arney jade of NASA's goddard space flight center.[72] see also list of the nearest stars 61 cygni in the narrative » stars and planetary systems in narrative » barnard star notes ^ by convention, 0 visual magnitude limit for the rayleigh criterion: l r â = 4 138 d {\displaystyle {\begin{smallmatrix}\alpha _{r} =\ {\frac {138}{ D}}\end{matrix small} â mm. r e â e) \cdot \circa \ 44\end{matrice piccola} â aual apoapsi: r a p â â â (â uri consulted on 7 February 2019. ^ a b "61 Cygni.= internet stellar database. 4 April 2011. url consulted on 3 February 2019. ^ a b c d blanco, c.; marilli, e.; Catalan, s. 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