= Proxima Centauri =

Proxima Centauri (from Latin , meaning " nearest [star] of Centaurus ") is a red dwarf , a small low @-@ mass star , about 4 @.@ 25 light @-@ years from the Sun , inside the G @-@ cloud , in the constellation of Centaurus . It was discovered in 1915 by the Scottish astronomer Robert Innes , the Director of the Union Observatory in South Africa , and is the nearest known star to the Sun , although it is too faint to be seen with the naked eye , with an apparent magnitude of 11 @.@ 05 . Its distance to the second- and third @-@ nearest stars , which form the bright binary Alpha Centauri , is 0 @.@ 237 ± 0 @.@ 011 ly (15 @,@ 000 ± 700 AU) . Proxima Centauri is very likely part of a triple star system with Alpha Centauri A and B , but its orbital period may be greater than 500 @,@ 000 years .

Because of Proxima Centauri 's proximity to Earth , its angular diameter can be measured directly . It is about one @-@ seventh the diameter of that of the Sun . It has a mass about an eighth of the Sun 's mass (M ?) , and its average density is about 40 times that of the Sun . Although it has a very low average luminosity , Proxima is a flare star that undergoes random dramatic increases in brightness because of magnetic activity . The star 's magnetic field is created by convection throughout the stellar body , and the resulting flare activity generates a total X @-@ ray emission similar to that produced by the Sun . The mixing of the fuel at Proxima Centauri 's core through convection and its relatively low energy @-@ production rate mean that it will be a main @-@ sequence star for another four trillion years , or nearly 300 times the current age of the universe .

Searches for companions orbiting Proxima Centauri have been unsuccessful , ruling out the presence of brown dwarfs and supermassive planets . Precision radial velocity surveys have also ruled out the presence of super @-@ Earths within the star 's habitable zone . The detection of smaller objects will require the use of new instruments , such as the James Webb Space Telescope , which is scheduled for deployment in 2018 . Because Proxima Centauri is a red dwarf and a flare star , whether a planet orbiting it could support life is disputed . Nevertheless , because of the star 's proximity to Earth , it has been proposed as a destination for interstellar travel .

= = Observation = =

In 1915 , the Scottish astronomer Robert Innes , Director of the Union Observatory in Johannesburg , South Africa , discovered a star that had the same proper motion as Alpha Centauri . He suggested that it be named Proxima Centauri (actually Proxima Centaurus) . In 1917 , at the Royal Observatory at the Cape of Good Hope , the Dutch astronomer Joan Voûte measured the star 's trigonometric parallax at 0 @.@ 755 ± 0 @.@ 028 ? and determined that Proxima Centauri was approximately the same distance from the Sun as Alpha Centauri . It was also found to be the lowest @-@ luminosity star known at the time . An equally accurate parallax determination of Proxima Centauri was made by American astronomer Harold L. Alden in 1928 , who confirmed Innes 's view that it is closer , with a parallax of 0 @.@ 783 ± 0 @.@ 005 ? .

In 1951 , American astronomer Harlow Shapley announced that Proxima Centauri is a flare star . Examination of past photographic records showed that the star displayed a measurable increase in magnitude on about 8 % of the images , making it the most active flare star then known . The proximity of the star allows for detailed observation of its flare activity . In 1980 , the Einstein Observatory produced a detailed X @-@ ray energy curve of a stellar flare on Proxima Centauri . Further observations of flare activity were made with the EXOSAT and ROSAT satellites , and the X @-@ ray emissions of smaller , solar @-@ like flares were observed by the Japanese ASCA satellite in 1995 . Proxima Centauri has since been the subject of study by most X @-@ ray observatories , including XMM @-@ Newton and Chandra .

Because of Proxima Centauri 's southern declination , it can only be viewed south of latitude 27 ° N. Red dwarfs such as Proxima Centauri are far too faint to be seen with the naked eye . Even from Alpha Centauri A or B , Proxima would only be seen as a fifth magnitude star . It has an apparent visual magnitude of 11 , so a telescope with an aperture of at least 8 cm (3 @.@ 1 in) is needed to observe it , even under ideal viewing conditions ? under clear , dark skies with Proxima Centauri

well above the horizon .

= = Characteristics = =

Proxima Centauri is a red dwarf , because it belongs to the main sequence on the Hertzsprung ? Russell diagram and is of spectral class M6 . M6 means that it falls in the low @-@ mass end of M @-@ type stars . Its absolute visual magnitude , or its visual magnitude as viewed from a distance of 10 parsecs , is 15 @.@ 5 . Its total luminosity over all wavelengths is 0 @.@ 17 % that of the Sun , although when observed in the wavelengths of visible light the eye is most sensitive to , it is only 0 @.@ 0056 % as luminous as the Sun . More than 85 % of its radiated power is at infrared wavelengths .

In 2002 , optical interferometry with the Very Large Telescope (VLTI) found that the angular diameter of Proxima Centauri was 1 @.@ 02 ± 0 @.@ 08 milliarcsec . Because its distance is known , the actual diameter of Proxima Centauri can be calculated to be about 1 / 7 that of the Sun , or 1 @.@ 5 times that of Jupiter . The star 's estimated mass is 12 @.@ 3 % M ? , or 129 Jupiter masses (MJ) . The mean density of a main @-@ sequence star increases with decreasing mass , and Proxima Centauri is no exception : it has a mean density of 56 @.@ 8 × 103 kg / m3 (56 @.@ 8 g / cm3) , compared with the Sun 's mean density of 1 @.@ 411 × 103 kg / m3 (1 @.@ 411 g / cm3) .

Because of its low mass , the interior of the star is completely convective , causing energy to be transferred to the exterior by the physical movement of plasma rather than through radiative processes . This convection means that the helium ash left over from the thermonuclear fusion of hydrogen does not accumulate at the core , but is instead circulated throughout the star . Unlike the Sun , which will only burn through about 10 % of its total hydrogen supply before leaving the main sequence , Proxima Centauri will consume nearly all of its fuel before the fusion of hydrogen comes to an end .

Convection is associated with the generation and persistence of a magnetic field . The magnetic energy from this field is released at the surface through stellar flares that briefly increase the overall luminosity of the star . These flares can grow as large as the star and reach temperatures measured as high as 27 million K ? hot enough to radiate X @-@ rays . Indeed , Proxima Centauri 's quiescent X @-@ ray luminosity , approximately (4 ? 16) × 1026 erg / s ((4 ? 16) × 1019 W) , is roughly equal to that of the much larger Sun . The peak X @-@ ray luminosity of the largest flares can reach 1028 erg / s (1021 W.)

Proxima Centauri 's chromosphere is active , and its spectrum displays a strong emission line of singly ionized magnesium at a wavelength of 280 nm . About 88 % of the surface of Proxima Centauri may be active , a percentage that is much higher than that of the Sun even at the peak of the solar cycle . Even during quiescent periods with few or no flares , this activity increases the corona temperature of Proxima Centauri to 3 @.@ 5 million K , compared to the 2 million K of the Sun 's corona . However , Proxima Centauri 's overall activity level is considered low compared to other red dwarfs , which is consistent with the star 's estimated age of 4 @.@ 85 × 109 years , since the activity level of a red dwarf is expected to steadily wane over billions of years as its stellar rotation rate decreases . The activity level also appears to vary with a period of roughly 442 days , which is shorter than the solar cycle of 11 years .

Proxima Centauri has a relatively weak stellar wind , no more than 20 % of mass loss rate of the solar wind . Because the star is much smaller than the Sun , however , the mass loss per unit surface area from Proxima Centauri may be eight times that from the solar surface .

A red dwarf with the mass of Proxima Centauri will remain on the main sequence for about four trillion years . As the proportion of helium increases because of hydrogen fusion , the star will become smaller and hotter , gradually transforming from red to blue . Near the end of this period it will become significantly more luminous , reaching 2 @.@ 5 % of the Sun 's luminosity (L ?) and warming up any orbiting bodies for a period of several billion years . When the hydrogen fuel is exhausted , Proxima Centauri will then evolve into a white dwarf (without passing through the red giant phase) and steadily lose any remaining heat energy .

= = = Distance and motion = = =

Based on the parallax of 768 @.@ 7 ± 0 @.@ 3 milliarcseconds , measured using the Hipparcos astrometry satellite , and more precisely with the Fine Guidance Sensors on the Hubble Space Telescope , Proxima Centauri is about 4 @.@ 24 light @-@ years (ly) from the Sun . A more recent and even more accurate parallax value from RECONS astrometry is 0 @.@ 76813 " , giving a distance of 4 @.@ 25 ly , or 270 @,@ 000 times more distant than Earth is from the Sun . From Earth 's vantage point , Proxima is separated from Alpha Centauri by 2 @.@ 18 degrees , or four times the angular diameter of the full Moon . Proxima also has a relatively large proper motion ? moving 3 @.@ 85 arcseconds per year across the sky . It has a radial velocity toward the Sun of 22 @.@ 4 km / s .

Among the known stars , Proxima Centauri has been the closest star to the Sun for about 32 @,@ 000 years and will be so for about another 25 @,@ 000 years , after which the closest star to the Sun will be Alpha Centauri . In 2001 , J. García @-@ Sánchez et al. predicted that Proxima will make its closest approach to the Sun , coming within 3 @.@ 11 ly , in approximately 26 @,@ 700 years . A 2010 study by V. V. Bobylev predicted a closest approach distance of 2 @.@ 90 ly in about 27 @,@ 400 years , followed by a 2014 study by C. A. L. Bailer @-@ Jones predicting a perihelion approach of 3 @.@ 07 ly in roughly 26 @,@ 710 years . Proxima Centauri is orbiting through the Milky Way at a distance from the Galactic Center that varies from 8 @.@ 3 to 9 @.@ 5 kpc , with an orbital eccentricity of 0 @.@ 07 .

Ever since the discovery of Proxima it has been suspected to be a true companion of the Alpha Centauri binary star system . At a distance to Alpha Centauri of just 0 @.@ 21 ly (15 @,@ 000 ± 700 AU) , Proxima Centauri may be in orbit around Alpha Centauri , with an orbital period of the order of 500 @,@ 000 years or more . For this reason , Proxima is sometimes referred to as Alpha Centauri C. Modern estimates , taking into account the small separation between and relative velocity of the stars , suggest that the chance of the observed alignment being a coincidence is roughly one in a million . Data from the Hipparcos satellite , combined with ground @-@ based observations , is consistent with the hypothesis that the three stars are truly a bound system . If so , Proxima would currently be near apastron , the farthest point in its orbit from the Alpha Centauri system . Such a triple system can form naturally through a low @-@ mass star being dynamically captured by a more massive binary of 1 @.@ 5 ? 2 M ? within their embedded star cluster before the cluster disperses . More accurate measurement of the radial velocity is needed to confirm this hypothesis .

If Proxima was bound to the Alpha Centauri system during its formation , the stars would be likely to share the same elemental composition . The gravitational influence of Proxima may also have stirred up the Alpha Centauri protoplanetary disks . This would have increased the delivery of volatiles such as water to the dry inner regions . Any terrestrial planets in the system may have been enriched by this material .

Six single stars , two binary star systems , and a triple star share a common motion through space with Proxima Centauri and the Alpha Centauri system . The space velocities of these stars are all within 10 km / s of Alpha Centauri 's peculiar motion . Thus , they may form a moving group of stars , which would indicate a common point of origin , such as in a star cluster . If it is determined that Proxima Centauri is not gravitationally bound to Alpha Centauri , then such a moving group would help explain their relatively close proximity .

Though Proxima Centauri is the nearest bona fide star , it is still possible that one or more as @-@ yet undetected sub @-@ stellar brown dwarfs may lie closer .

= = = Possible companions = = =

If a massive planet is orbiting Proxima Centauri , it would cause some displacement of Proxima Centauri over the course of the planet 's orbit . If the orbital plane of the planet is not perpendicular to the line of sight from Earth , then this displacement would cause periodic changes in the radial

velocity of Proxima Centauri . The fact that multiple measurements of the star 's radial velocity have detected no such shifts has lowered the maximum mass that a detectable companion to Proxima Centauri could possess . The activity level of the star adds noise to the radial velocity measurements , limiting future prospects for detection of a companion using this method .

In 1998 , an examination of Proxima Centauri using the Faint Object Spectrograph on board the Hubble Space Telescope appeared to show evidence of a companion orbiting at a distance of about 0 @.@ 5 AU . However , a subsequent search using the Wide Field Planetary Camera 2 failed to locate any companions . Astrometric measurements at the Cerro Tololo Inter @-@ American Observatory appear to rule out a Jovian companion with an orbital period of 2 ? 12 years .

Proxima Centauri , along with Alpha Centauri A and B , was among the " Tier 1 " target stars for NASA 's now @-@ canceled Space Interferometry Mission (SIM) , which would theoretically have been able to detect planets as small as three Earth masses (M ?) within two AU of a " Tier 1 " target star .

= = = Habitable zone = = =

The TV documentary Alien Worlds hypothesized that a life @-@ sustaining planet could exist in orbit around Proxima Centauri or other red dwarfs . Such a planet would lie within the habitable zone of Proxima Centauri , about 0 @.@ 023 ? 0 @.@ 054 AU from the star , and would have an orbital period of 3 @.@ 6 ? 14 days . A planet orbiting within this zone will experience tidal locking to the star , so that Proxima Centauri moves little in the planet 's sky , and most of the surface experiences either day or night perpetually . However , the presence of an atmosphere could serve to redistribute the energy from the star @-@ lit side to the far side of the planet .

Proxima Centauri 's flare outbursts could erode the atmosphere of any planet in its habitable zone , but the documentary 's scientists thought that this obstacle could be overcome (see continued theories) . Gibor Basri of the University of California , Berkeley , even mentioned that " no one [has] found any showstoppers to habitability . " For example , one concern was that the torrents of charged particles from the star 's flares could strip the atmosphere off any nearby planet . However , if the planet had a strong magnetic field , the field would deflect the particles from the atmosphere ; even the slow rotation of a tidally locked dwarf planet that spins once for every time it orbits its star would be enough to generate a magnetic field , as long as part of the planet 's interior remained molten .

Other scientists , especially proponents of the Rare Earth hypothesis , disagree that red dwarfs can sustain life . Any exoplanet in this star 's habitable zone would likely be tidally @-@ locked resulting in a relatively weak planetary magnetic moment , leading to strong atmospheric erosion by coronal mass ejections from Proxima Centauri .

= = Interstellar travel = =

Proxima Centauri has been suggested as a possible first destination for interstellar travel . Proxima currently moves toward Earth at a rate of 22 @.@ 4 km / s . ?owever , after 26 @,@ 700 years , when it will come as close as 3 @.@ 11 light @-@ years , it will begin to move farther away . If non @-@ nuclear propulsion were used , a flight of a spacecraft to a planet orbiting Proxima Centauri would probably require thousands of years . For example , Voyager 1 , which is now travelling 17 @.@ 043 km / s (38 @,@ 120 mph) relative to the Sun , would reach Proxima in 73 @,@ 775 years , were the spacecraft traveling in the direction of that star . A slow @-@ moving probe would have only several tens of thousands of years to catch Proxima Centauri near its closest approach , and could end up watching it recede into the distance . Nuclear pulse propulsion might enable such interstellar travel with a trip timescale of a century , beginning within the next century , inspiring several studies such as Project Orion , Project Daedalus , and Project Longshot .

From Proxima Centauri , the Sun would appear as a bright 0 @.@ 4 @-@ magnitude star in the constellation Cassiopeia .

= = = Explanatory notes = = =