Epsilon Eridani

Epsilon Eridani (? Eri , ? Eridani) , or Ran , is a star in the southern constellation Eridanus , along a declination 9 @.@ 46 ° south of the celestial equator . This allows it to be viewed from most of Earth 's surface . At a distance of 10 @.@ 5 light years (ly) , it has an apparent magnitude of 3 @.@ 73 . It is the third closest individual star or star system visible to the unaided eye and is the closest star known to host a planet . Its age is estimated at less than a billion years . Because of its youth , Epsilon Eridani has a higher level of magnetic activity than the present @-@ day Sun , with a stellar wind 30 times as strong . Its rotation period is 11 @.@ 2 days at the equator . Epsilon Eridani is smaller and less massive than the Sun , and has a comparatively lower level of elements heavier than helium . It is a main @-@ sequence star of spectral class K2 , which means that energy generated at the core through nuclear fusion of hydrogen is emitted from the surface at a temperature of about 5 @,@ 000 K , giving it an orange hue .

The motion of Epsilon Eridani along the line of sight to Earth , known as the radial velocity , has been regularly observed for more than twenty years . Periodic changes in this data yielded evidence of a giant planet orbiting Epsilon Eridani , making it one of the nearest extrasolar systems with a candidate exoplanet . The detection of this orbiting planetary object , Epsilon Eridani b , was announced by Bruce Campbell , Gordon Walker and Stephenson Yang in 1987 . A preliminary orbit was published in 2000 by a team of astronomers led by Artie Hatzes , based on six independent data sets with four different telescopes . Current data indicate that this planet orbits with a period of about 7 years at a mean separation of 3 @.@ 4 astronomical units (AU) , where 1 AU is the mean distance between Earth and the Sun . Although this discovery has been controversial because of the amount of background noise in the radial velocity data , many astronomers now regard the planet as confirmed .

The system includes two belts of rocky asteroids : one at about 3 AU and a second at about 20 AU , whose structure may be maintained by a hypothetical second planet , Epsilon Eridani c . Epsilon Eridani harbors an extensive outer debris disk of remnant planetesimals left over from the system 's formation .

Epsilon Eridani 's designation was established in 1603 by Johann Bayer . It may be a member of the Ursa Major Moving Group of stars that share a similar motion through the Milky Way , implying these stars shared a common origin in an open cluster . Its nearest neighbor , the binary star system Luyten 726 @-@ 8 , will have a close encounter with Epsilon Eridani in approximately 31 @,@ 500 years when they will be separated by about 0 @.@ 93 ly . As one of the nearest Sun @-@ like stars with the potential for a planet that may harbor life , Epsilon Eridani has been the target of SETI searches . Epsilon Eridani appears in science fiction stories and has been suggested as a destination for interstellar travel . From Epsilon Eridani , the Sun would appear as a 2 @.@ 4 @-@ magnitude star in Serpens .

Observation history

Cataloguing

Epsilon Eridani has been known to astronomers since at least the 2nd century , when it was included by Claudius Ptolemy , a Greek astronomer from Alexandria , Egypt , in his catalogue of more than 1000 stars . The catalogue was included as the 7th (northern sky) and 8th (southern sky) books of his 13 @-@ book astronomical treatise ?????????? ???????? (Math?matik? Syntaxis) , known by its later Arabic name Almagest . Constellation Eridanus , named by Ptolemy " ??????? " (" River ") , was included in the 8th book as the 9th constellation (or 36th from the beginning) , and Epsilon Eridani was the 13th star , listed in the River . Ptolemy called Epsilon Eridani " ? ??? ? ???????????? " (here " ? " is number " 4 ") , which means in Greek " a foregoing of the four " . The " four " is a group of four stars in Eridanus : ? , ? , ? and ? (10th ? 13th) , of which ? is the most western , and thus , the first of the four in the apparent daily motion of the sky from east to west . The modern designations of its entry in Ptolemy 's catalogue are " P 784 " (in order of appearance) and " Eri 13 " . The magnitude , assigned to Epsilon Eridani by Ptolemy , was 3 .

Epsilon Eridani was included in star catalogues of medieval Islamic astronomical treatises , which were based on Ptolemy 's catalogue : in Al @-@ Sufi 's Book of Fixed Stars , published in 964 , Al @-@ Biruni 's Mas 'ud Canon , published in 1030 , and Ulugh Beg 's Zij @-@ i Sultani , published in 1437 . Al @-@ Sufi 's estimate of Epsilon Eridani 's magnitude was 3 . Al @-@ Biruni quotes magnitudes from Ptolemy and Al @-@ Sufi (however , for Epsilon Eridani he quotes the value 4 for both Ptolemy 's and Al @-@ Sufi 's magnitudes , whereas original values of both these magnitudes are 3) . Its number in order of appearance is 786 . Ulugh Beg carried out new measurements of Epsilon Eridani 's coordinates in his observatory at Samarkand , and quotes magnitudes from Al @-@ Sufi (3 for Epsilon Eridani) . The modern designations of its entry in Ulugh Beg 's catalogue are " U 781 " and " Eri 13 " (the latter is the same as Ptolemy 's catalogue designation) .

In 1598 Epsilon Eridani was included in Tycho Brahe 's star catalogue , republished also in 1627 by Johannes Kepler as part of his Rudolphine Tables . This catalogue was based on Tycho Brahe 's observations including those on the island of Hven at his observatories Uraniborg and Stjerneborg , during 1577 ? 1597 . The sequence number of Epsilon Eridani in constellation Eridanus was 10 , and it was designated " Quae omnes quatuor antecedit " , which means in Latin " Which precedes all four " ; the meaning is the same as Ptolemy 's designation . Brahe assigned it magnitude 3 .

Epsilon Eridani 's Bayer designation was established in 1603 as part of the Uranometria , a star catalogue produced by German celestial cartographer Johann Bayer . His catalogue assigned letters from the Greek alphabet to groups of stars belonging to the same visual magnitude class in each constellation , beginning with alpha (?) for a star in the brightest class . However , Bayer made no attempt to arrange stars by relative brightness within each class . Thus , although Epsilon is the fifth letter in the Greek alphabet , the star is the tenth brightest star in Eridanus . In addition to the letter ? , Bayer had given it the number 13 (the same as Ptolemy 's catalogue number , as were many of Bayer 's numbers) and designation " Decima septima " , which means in Latin " The seventeenth " . The meaning of this : Bayer designated 21 stars in the northern part of Eridanus along the river from east to west from the first (? , " Supra pedem Orionis in flumine , prima " , that is " Above the foot of Orion in the river , the first ") to the twenty @-@ first (? , " Vigesima prima " , that is " the twenty @-@ first ") , and Epsilon Eridani was the seventeenth of them . These 21 stars are : ? , ? , ? , b , ? , ? , c , ? , ? , ? (two stars) , d , A , ? , ? , ? , ? , ? , ? , ? , ? . Bayer assigned Epsilon Eridani magnitude 3 .

In 1690 Epsilon Eridani was included in the star catalogue of Johannes Hevelius . Its sequence number in constellation Eridanus was 14 , its designation was " Tertia " (" the third ") , and it was assigned magnitude 3 (according to Verbunt and Gent) or 4 (according to Baily) . The star catalogue of English astronomer John Flamsteed , published in 1712 , gave Epsilon Eridani the Flamsteed designation 18 Eridani because it was the eighteenth catalogued star in the constellation of Eridanus by order of increasing right ascension . In 1818 Epsilon Eridani was included in Friedrich Bessel 's catalogue , based on James Bradley 's observations during 1750 ? 1762 . Assigned magnitude was 4 . It also appeared in Nicolas Louis de Lacaille 's catalogue of 398 principal stars , whose 307 @-@ star version was published in 1755 in the Ephémérides des Mouvemens Célestes , pour dix années , 1755 ? 1765 , and whose full version was published in 1757 in Astronomiæ Fundamenta , Paris . In its 1831 edition by Francis Baily Epsilon Eridani has the number 50 . Lacaille assigned it magnitude 3 .

In 1801 Epsilon Eridani was included in Histoire Céleste Française , Joseph Jérôme Lefrançois de Lalande 's catalogue of about 50 @,@ 000 stars , based on his observations during 1791 ? 1800 , in which observations are arranged in a time order . It contains three observations of Epsilon Eridani : 1796 September 17 (page 246) , 1796 December 3 (page 248) and 1797 November 13 (page 307) . In 1847 , an edition of Lalande 's catalogue (Francis Baily et al .) was published , containing the majority of its observations , in which the stars were numbered in order of right ascension . Because every observation of every star was numbered and Epsilon Eridani was observed three times , it got three numbers : 6581 , 6582 and 6583 . (Today numbers from this catalogue are used with the prefix " Lalande " , or " Lal ") . Lalande assigned Epsilon Eridani magnitude 3 . Also in 1801 it was included in the catalogue of Johann Bode , in which about 17 @,@ 000 stars were grouped into 102 constellations and numbered (Epsilon Eridani got the number 159 in the constellation Eridanus) . Bode 's catalogue was based on observations of various astronomers , including Bode himself , but mostly on Lalande 's and Lacaille 's (for the southern sky) , and an observer for Epsilon Eridani was Lalande . Bode assigned Epsilon Eridani magnitude 3 . In 1814 Giuseppe Piazzi published the second edition of his star catalogue (its first edition was published in 1803) , based on observations during 1792 ? 1813 , in which more than 7000 stars were grouped into 24 hours (0 ? 23) . Epsilon Eridani is number 89 in hour 3 . Piazzi assigned it magnitude 4 . In 1918 Epsilon Eridani appeared in the Henry Draper Catalogue with the designation HD 22049 and a preliminary spectral classification of K0 .

= = = Detection of proximity = = =

Based on observations between 1800 and 1880 , Epsilon Eridani was found to have a large proper motion across the celestial sphere , which was estimated at an angular velocity of three arcseconds annually . This movement implied it was relatively close to the Sun , making it a star of interest for the purpose of trigonometric parallax measurements . This process involves recording the position of Epsilon Eridani as Earth moves around the Sun , which allows a star 's distance to be estimated . From 1881 to 1883 , American astronomer William L. Elkin used a heliometer at the Royal Observatory at the Cape of Good Hope , South Africa to compare the position of Epsilon Eridani with two nearby stars . From these observations , a parallax of 0 @.@ 14 ± 0 @.@ 02 arcseconds was calculated . By 1917 , observers had refined their parallax estimate to 0 @.@ 317 arcseconds . The modern value of 0 @.@ 3109 arcseconds is equivalent to a distance of about 10 @.@ 50 ly (3 @.@ 22 parsecs) .

= = = Circumstellar discoveries = = =

Based on unexplained changes in the position of Epsilon Eridani between 1938 and 1972 , Dutch ? American astronomer Peter van de Kamp proposed that an unseen companion with an orbital period of 25 years was causing gravitational perturbations in its position . This claim was refuted in 1993 by German astronomer Wulff @-@ Dieter Heintz and the false detection was blamed on a systematic error in the photographic plates .

Launched in 1983 , the space telescope IRAS detected infrared emissions from stars near to the Sun . Two years later , the presence of an excess infrared emission close to Epsilon Eridani was announced , which indicated a disk of fine @-@ grained cosmic dust was orbiting Epsilon Eridani . This debris disk has since been extensively studied . Evidence for a planetary system was discovered in 1998 by the observation of asymmetries in this dust ring . These clumps of dust could be explained by gravitational interaction with a planet orbiting just inside the ring of dust .

In 1987 , the detection of an orbiting planetary object was announced by Bruce Campbell , Gordon Walker and Stephenson Yang . From 1980 to 2000 , a team of astronomers led by American Artie P. Hatzes made radial velocity observations of Epsilon Eridani , measuring changes in motion of Epsilon Eridani along the line of sight to Earth , which provided evidence of the gravitational effect of a planet orbiting it with a period of about seven years . Although there is a high level of noise in the radial velocity data due to magnetic activity in its photosphere , any periodicity caused by this magnetic activity is expected to show a strong correlation with variations in emission lines of ionized calcium (the Ca II H and K lines) . Because no such correlation was found , a planetary companion was deemed the most likely cause . This discovery was supported by astrometric measurements of Epsilon Eridani made between 2001 and 2003 with the Hubble Space Telescope , which showed evidence for gravitational perturbation of Epsilon Eridani by a planet .

American astrophysicist Alice C. Quillen and her student Stephen Thorndike performed computer simulations of the structure of the dust disk around Epsilon Eridani . Their model suggested that the clumping of the dust particles could be explained by the presence of a second planet in an eccentric orbit . They announced this finding in 2002 .

= = = SETI and proposed exploration = = =

In 1960 , American physicist Philip Morrison and Italian physicist Giuseppe Cocconi proposed that extraterrestrial civilizations might be using radio signals for communication . Project Ozma , headed by American astronomer Frank Drake , used the Tatel Telescope to search for such signals from the nearby Sun @-@ like stars Epsilon Eridani and Tau Ceti . The systems were observed at the emission frequency of neutral hydrogen , 1 @,@ 420 MHz . No signals of intelligent extraterrestrial origin were detected . Drake repeated the experiment in 2010 , with the same negative result . Despite this lack of success , Epsilon Eridani made its way into science fiction literature and television shows for many years following news of Drake 's initial experiment .

In Habitable Planets for Man , a 1964 RAND Corporation study by American space scientist Stephen H. Dole , the probability of a habitable planet being in orbit around Epsilon Eridani were estimated at 3 @.@ 3 % . Among the known stars within 22 ly , it was listed with the 14 stars that were thought most likely to have a habitable planet .

American space scientist William I. McLaughlin proposed a new strategy in the search for extraterrestrial intelligence (SETI) in 1977 . He suggested that widely observable events such as nova explosions might be used by intelligent extraterrestrials to synchronize the transmission and reception of their signals . This idea was tested from the National Radio Astronomy Observatory in 1988 , which used outbursts of Nova Cygni 1975 as the timer . Fifteen days of observation showed no anomalous radio signals coming from Epsilon Eridani .

Because of the proximity and Sun @-@ like properties of Epsilon Eridani , American physicist Robert L. Forward considered the system as one of the targets for interstellar travel in 1985 . The following year , the British Interplanetary Society suggested Epsilon Eridani as one of several targets in its Project Daedalus paper study . The system has continued to be among the targets of such proposals , as with Project Icarus in 2011 .

Based on its location within 23 @.@ 5 ly (7 @.@ 2 parsecs) , Epsilon Eridani was among the target stars of Project Phoenix , a 1995 microwave survey for signals from extraterrestrial intelligence . The project had checked about 800 stars by 2004 , but had not yet detected an unimpeachable signal .

= = Properties = =

At a distance of 10 @.@ 50 ly (3 @.@ 22 parsecs) , Epsilon Eridani is the 13th @-@ nearest known star (and ninth nearest solitary star or stellar system) to the Sun as of 2014 . Its proximity makes it one of the most studied stars of its stellar classification . Epsilon Eridani is located in the northern part of the constellation Eridanus , about 3 ° east of the slightly brighter star Delta Eridani . With a declination of ? 9 @.@ 46 ° , Epsilon Eridani can be viewed from much of Earth 's surface . Only to the north of latitude 80 ° N is it permanently hidden below the horizon . The apparent magnitude of 3 @.@ 73 can make it difficult to observe from an urban area with the unaided eye , because the night skies over cities are obscured by light pollution .

Epsilon Eridani has an estimated 82 % of the Sun 's mass and 74 % of the Sun 's radius , but only 34 % of its luminosity . The estimated surface temperature is 5 @,@ 084 K. With a stellar classification of K2 V , it is the second @-@ nearest K @-@ type main @-@ sequence star after Alpha Centauri B. Indeed , since 1943 , the spectrum of Epsilon Eridani has served as one of the stable anchor points by which other stars are classified . Its metallicity , or enrichment in elements heavier than helium , is slightly lower than the Sun 's . In Epsilon Eridani 's chromosphere , a region of the outer atmosphere just above the light emitting photosphere , the proportion of iron is estimated at 74 % of the Sun 's abundance .

Epsilon Eridani 's K @-@ type classification indicates that the spectrum has relatively weak absorption lines from energy absorbed by hydrogen and strong lines of neutral atoms and singly ionized calcium (Ca II) . The luminosity class V is assigned to stars that are undergoing thermonuclear fusion of hydrogen in their core . For a K @-@ type main @-@ sequence star , this fusion is dominated by the proton ? proton chain reaction , wherein a series of mergers of four hydrogen nuclei results in a helium nucleus . In their inner region , energy is transported outward from the core by means of radiation , which results in no net motion of the surrounding plasma . Outside of this region , in their envelope , energy is carried to the photosphere by plasma convection , where it then radiates into space .

= = = Magnetic activity = = =

Epsilon Eridani has a higher level of magnetic activity than the Sun , and hence demonstrates increased activity in the outer parts of its atmosphere : the chromosphere and corona . The average magnetic @-@ field strength of Epsilon Eridani across the entire surface is (1 @.@ 65 ± 0 @.@ 30) × 10 ? 2 T , which is more than forty times greater than the (5 ? 40) × 10 ? 5 T magnetic @-@ field strength in the Sun 's photosphere . The magnetic properties can be modeled by assuming that regions with a magnetic flux of about 0 @.@ 14 T randomly cover approximately 9 % of the photosphere , whereas the remainder of the surface is free of magnetic fields . The overall magnetic activity of Epsilon Eridani is irregular , but it may vary with a 4 @.@ 9 @-@ year period . Assuming that its radius does not change over this interval , the long @-@ term variation in activity level appears to produce a temperature variation of 15 K , which corresponds to a variation in visual magnitude (V) of 0 @.@ 014 .

The magnetic field on the surface of Epsilon Eridani causes variations in the hydrodynamic behavior of the photosphere . This results in greater jitter during measurements of its radial velocity Doppler shift . Variations of 15 m s ? 1 were measured over a 20 year period , which is much higher than the measurement error rate of 3 m s ? 1 . This makes interpretation of periodicities in the radial velocity of Epsilon Eridani , such as those caused by the gravitational perturbations of an orbiting planet , more difficult .

Epsilon Eridani is classified as a BY Draconis variable because it has regions of higher magnetic activity that move into and out of the line of sight as it rotates . Measurement of this rotational modulation suggests that its equatorial region rotates with an average period of 11 @.@ 2 days , which is less than half of the rotation period of the Sun . Observations have shown that Epsilon Eridani varies as much as 0 @.@ 050 in V magnitude due to starspots and other short @-@ term magnetic activity . Photometry has also shown that the surface of Epsilon Eridani , like the Sun , is undergoing differential rotation , which means that the rotation period at the surface varies by latitude . The measured periods range from 10 @.@ 8 to 12 @.@ 3 days . The axial tilt of Epsilon Eridani toward the line of sight from Earth is uncertain . Estimates range from 24 ° to 72 ° .

The high levels of chromospheric activity , strong magnetic field , and relatively fast rotation rate of Epsilon Eridani are characteristic of a young star . The age of Epsilon Eridani is about 440 million years , but this remains subject to debate . Most age estimation methods place it in the range from 200 million to 800 million years . However , the low abundance of heavy elements in the chromosphere of Epsilon Eridani is indicative of an older star , because the medium out of which stars form is steadily enriched by heavier elements produced by older generations of stars . This anomaly might be caused by a diffusion process that has transported some of the helium and heavier elements out of the photosphere and into a region below Epsilon Eridani 's convection zone .

The X @-@ ray luminosity of Epsilon Eridani is about 2 × 1028 ergs / s (2 × 1021 W) . It is brighter in X @-@ ray emission than the Sun at peak activity . The source for this strong X @-@ ray emission is Epsilon Eridani 's hot corona . Epsilon Eridani 's corona appears larger and hotter than the Sun 's , with a temperature of 3 @.@ 4 × 106 K as measured from observation of the corona 's ultraviolet and X @-@ ray emission .

The stellar wind emitted by Epsilon Eridani expands until it collides with the surrounding interstellar medium of sparse gas and dust , resulting in a bubble of heated hydrogen gas . The absorption spectrum from this gas has been measured with the Hubble Space Telescope , allowing the properties of the stellar wind to be estimated . Epsilon Eridani 's hot corona results in a mass loss rate from Epsilon Eridani 's stellar wind that is 30 times higher than the Sun 's . This wind is generating an astrosphere (the equivalent of the heliosphere that surrounds the Sun) that spans about 8 @,@ 000 AU and contains a bow shock that lies 1 @,@ 600 AU from Epsilon Eridani . At its estimated distance from Earth , this astrosphere spans 42 arcminutes , which is wider than the apparent size of the full Moon .

Kinematics

Epsilon Eridani has a high proper motion , moving ? 0 @.@ 976 arcseconds per year in right ascension (the celestial longitude) and 0 @.@ 018 arcseconds per year in declination (the celestial latitude) , for a total proper motion of 0 @.@ 962 arcseconds per year . It has a radial velocity of + 15 @.@ 5 km / s away from the Sun . The space velocity components of Epsilon Eridani in the galactic coordinate system are (U , V , W) = (? 3 , + 7 , ? 20) km / s , which means that it is traveling within the Milky Way at a mean galactocentric distance of 28 @.@ 7 kly (8 @.@ 79 kiloparsecs) from the core along an orbit that has an eccentricity of 0 @.@ 09 . The velocity and heading of Epsilon Eridani indicate that it may be a member of the Ursa Major Moving Group that share a common motion through space . This behavior suggests that the members originated in an open cluster that has since diffused . The estimated age of this group is 500 ± 100 million years , which lies within the range of the age estimates for Epsilon Eridani .

During the past million years , three stars are believed to have come within 7 ly (2 parsecs) of Epsilon Eridani . The most recent and closest of these encounters was with Kapteyn 's Star , which approached to a distance of about 3 ly (0 @.@ 9 parsecs) roughly 12 @,@ 500 years ago . The other two stars were Sirius and Ross 614 . None of these encounters are thought to have affected the circumstellar disk orbiting Epsilon Eridani .

Epsilon Eridani made its closest approach to the Sun about 105 @,@ 000 years ago , when they were separated by 7 ly (2 @.@ 1 parsecs) . Based upon a simulation of close encounters with nearby stars , the binary star system Luyten 726 @-@ 8 , which includes the variable star UV Ceti , will encounter Epsilon Eridani in approximately 31 @,@ 500 years at a minimum distance of about 0 @.@ 9 ly (0 @.@ 29 parsecs) . They will be less than 1 ly (0 @.@ 3 parsecs) apart for about 4 @,@ 600 years . If Epsilon Eridani has an Oort cloud , Luyten 726 @-@ 8 could gravitationally perturb some of the comets with long orbital periods .

Planetary system

Dust disk

Observations with the James Clerk Maxwell Telescope at a wavelength of 850 ?m show an extended flux of radiation out to an angular radius of 35 arcseconds around Epsilon Eridani . The peak emission occurs at an angular radius of 18 arcseconds , which corresponds to a radius of about 60 AU . The highest level of emission occurs over the radius 35 ? 75 AU from Epsilon Eridani and is substantially reduced inside 30 AU . This emission is interpreted as coming from a young analogue of the Solar System 's Kuiper belt : a compact dusty disk structure surrounding Epsilon Eridani . From Earth , this belt is viewed at an inclination of roughly 25 ° to the line of sight .

Dust and possibly water ice from this belt migrates inward because of drag from the stellar wind and a process by which stellar radiation causes dust grains to slowly spiral toward Epsilon Eridani , known as the Poynting ? Robertson effect . At the same time , these dust particles can be destroyed through mutual collisions . The time scale for all of the dust in the disk to be cleared away by these processes is less than Epsilon Eridani 's estimated age . Hence , the current dust disk must have been created by collisions or other effects of larger parent bodies , and the disk represents a late stage in the planet @-@ formation process . It would have required collisions between 11 Earth masses ' worth of parent bodies to have maintained the disk in its current state over its estimated age .

The disk contains an estimated mass of dust equal to a sixth of the mass of the Moon , with individual dust grains exceeding 3 @.@ 5 ?m in size at a temperature of about 55 K. This dust is being generated by the collision of comets , which range up to 10 to 30 km in diameter and have a combined mass of 5 to 9 times that of Earth . This is similar to the estimated 10 Earth masses in the primordial Kuiper belt . However , the disk around Epsilon Eridani contains less than 2 @.@ 2 × 1017 kg of carbon monoxide . This low level suggests a paucity of volatile @-@ bearing comets and icy planetesimals compared to the Kuiper belt .

The clumpy structure of the dust belt may be explained by gravitational perturbation from a planet , dubbed Epsilon Eridani b . The clumps in the dust occur at orbits that have an integer resonance with the orbit of the suspected planet . For example , the region of the disk that completes two orbits for every three orbits of a planet is in a 3 : 2 orbital resonance . In computer simulations the ring morphology can be reproduced by the capture of dust particles in 5 : 3 and 3 : 2 orbital resonances with a planet that has an orbital eccentricity of about 0 @.@ 3 . Alternatively , the clumpiness may have been caused by collisions between minor planets known as plutinos .

Observations from NASA 's Spitzer Space Telescope suggest that Epsilon Eridani actually has two asteroid belts and a cloud of exozodiacal dust . The latter is an analog of the zodiacal dust that occupies the plane of the Solar System . One belt sits at approximately the same position as the one in the Solar System , orbiting at a distance of 3 @.@ 00 ± 0 @.@ 75 AU from Epsilon Eridani , and consists of silicate grains with a diameter of 3 ?m and a combined mass of about 1018 kg . If the planet Epsilon Eridani b exists then this belt is unlikely to have had a source outside the orbit of the planet , so the dust may have been created by fragmentation and cratering of larger bodies such as asteroids . The second , denser belt , most likely also populated by asteroids , lies between the first belt and the outer comet disk . The structure of the belts and the dust disk suggests that more than two planets in the Epsilon Eridani system are needed to maintain this configuration .

In an alternative scenario , the exozodiacal dust may be generated in an outer belt that is orbiting between 55 and 90 AU from Epsilon Eridani and has an assumed mass of 10 ? 3 times the mass of Earth . This dust is then transported inward past the orbit of Epsilon Eridani b . When collisions between the dust grains are taken into account , the dust will reproduce the observed infrared spectrum and brightness . Outside the radius of ice sublimation , located beyond 10 AU from Epsilon Eridani where the temperatures fall below 100 K , the best fit to the observations occurs when a mix of ice and silicate dust is assumed . Inside this radius , the dust must consist of silicate grains that lack volatiles .

The inner region around Epsilon Eridani , from a radius of 2 @.@ 5 AU inward , appears to be clear of dust down to the detection limit of the 6 @.@ 5 m MMT telescope . Grains of dust in this region are efficiently removed by drag from the stellar wind , while the presence of a planetary system may also help keep this area clear of debris . Still , this does not preclude the possibility that an inner asteroid belt may be present with a combined mass no greater than the asteroid belt in the Solar System .

= = = Possible planets = = =

As one of the nearest Sun @-@ like stars , Epsilon Eridani has been the target of many attempts to search for planetary companions . However , its chromospheric activity and variability means that finding planets with the radial velocity method is difficult , because the stellar activity may create signals that mimic the presence of planets . Attempts at direct imaging of potential exoplanets have proven unsuccessful to date .

Infrared observation has shown there are no bodies of three or more Jupiter masses in this system , out to at least a distance of 500 AU from the host star . Planets with similar masses and temperatures as Jupiter should be detectable by Spitzer at distances beyond 80 AU , but none has been discovered in this range . Planets more than 150 % as massive as Jupiter can be ruled out at the inner edge of the debris disk at 30 ? 35 AU .

= = = = Planet b = = = =

Referred to as Epsilon Eridani b , this planet was announced in 2000 , but the discovery has remained controversial . A comprehensive study in 2008 called the detection " tentative " and described the proposed planet as " long suspected but still unconfirmed " . However , many astronomers believed the evidence is sufficiently compelling that they regard the discovery as confirmed . As of 2013 , the discovery remains in doubt because a search program at La Silla Observatory did not confirm it exists .
Published sources remain in disagreement as to the proposed planet 's basic parameters . Values for its orbital period range from 6 @.@ 85 to 7 @.@ 2 years . Estimates of the size of its elliptical orbit ? the semimajor axis ? range from 3 @.@ 38 AU to 3 @.@ 50 AU and approximations of its orbital eccentricity range from 0 @.@ 25 ± 0 @.@ 23 to 0 @.@ 702 ± 0 @.@ 039 .
The true mass of this planet remains unknown , but it can be estimated based on the displacement effect of the planet 's gravity on Epsilon Eridani . Only the component of the displacement along the line of sight to Earth is known , which yields a value for the formula m sin i , where m is the mass of the planet and i is the orbital inclination . Estimates for the value of m sin i range from 0 @.@ 60 Jupiter masses to 1 @.@ 06 Jupiter masses , which sets the lower limit for the mass of the planet (because the sine function has a maximum value of 1) . By choosing a mass of 0 @.@ 78 and an estimated inclination of 30 ° , this yields the frequently cited value of 1 @.@ 55 ± 0 @.@ 24 Jupiter masses for the planet 's mass .
Of all the measured parameters for this planet , the value for orbital eccentricity is the most uncertain . The frequently cited value of 0 @.@ 7 for Epsilon Eridani b 's eccentricity is inconsistent with the presence of the proposed asteroid belt at a distance of 3 AU . If the eccentricity was actually this high , the planet would pass through the asteroid belt and clear it out within about ten thousand years . If the belt has existed for longer than this period , which appears likely , it imposes an upper limit on Epsilon Eridani b 's eccentricity of about 0 @.@ 10 ? 0 @.@ 15 . If the dust disk is instead being generated from the outer debris disk , rather than from collisions in an asteroid belt , then no constraints on the planet 's orbital eccentricity are needed to explain the dust distribution .
The planet and its host star is one of the planetary systems selected by the International Astronomical Union as part of their public process for giving proper names to exoplanets and their host star (where no proper name already exists) . The process involved public nomination and voting for the new names . In December 2015 , the IAU announced the winning names were Ran for the star and AEgir for the planet , both names from Norse mythology .

= = = = Planet c = = = =

Computer simulations of the dusty disk orbiting Epsilon Eridani suggest that the shape of the disk may be explained by the presence of a second planet , tentatively dubbed Epsilon Eridani c . Clumping in the dust disk may occur because dust particles are being trapped in orbits that have resonant orbital periods with a planet in an eccentric orbit . The postulated Epsilon Eridani c would orbit at a distance of 40 AU , with an eccentricity of 0 @.@ 3 and a period of 280 years . The inner cavity of the disk may be explained by the presence of additional planets . Current models of planet formation cannot easily explain how a planet could have been created at this distance from Epsilon Eridani . The disk is expected to have dissipated long before a giant planet could have formed . Instead , the planet may have formed at an orbital distance of about 10 AU then migrated outward because of gravitational interaction with the disc or with other planets in the system .

= = = = Potential habitability = = = =

Epsilon Eridani is a target for planet finding programs because it has properties that allow an Earth @-@ like planet to form . Although this system was not chosen as a primary candidate for the now @-@ canceled Terrestrial Planet Finder , it was a target star for NASA 's proposed Space Interferometry Mission to search for Earth @-@ sized planets . The proximity , Sun @-@ like properties and suspected planets of Epsilon Eridani have also made it the subject of multiple studies on whether an interstellar probe can be sent to Epsilon Eridani .

The orbital radius at which the stellar flux from Epsilon Eridani matches the solar constant ? where the emission matches the Sun 's output at the orbital distance of the Earth ? is 0 @.@ 61 astronomical units (AU) . That is within the maximum habitable zone of a conjectured Earth @-@ like planet orbiting Epsilon Eridani , which currently stretches from about 0 @.@ 5 to 1 @.@ 0 AU . As Epsilon Eridani ages over a period of 20 billion years , the net luminosity will increase , causing this zone to slowly expand outward to about 0 @.@ 6 ? 1 @.@ 4 AU . However , the presence of a large planet with a highly elliptical orbit in proximity to Epsilon Eridani 's habitable zone reduces the likelihood of a terrestrial planet having a stable orbit within the habitable zone .

A young star such as Epsilon Eridani can produce large amounts of ultraviolet radiation that may be harmful to life . The orbital radius where the UV flux matches that on the early Earth lies at just under 0 @.@ 5 AU . Epsilon Eridani 's proximity , Sun @-@ like properties and suspected planets have made it a destination for interstellar travel in science fiction stories .

From Epsilon Eridani , the Sun would appear as a 2 @.@ 4 @-@ magnitude star in Serpens .