

Fomalhaut

Fomalhaut, also designated **Alpha Piscis Austrini** (**α Piscis Austrini**, abbreviated **Alpha PsA**, **α PsA**) is the brightest star in the constellation of Piscis Austrinus and one of the brightest stars in the sky. It is a class A star on the main sequence approximately 25 light-years (7.7 pc) from the Sun as measured by the Hipparcos astrometry satellite.^[11] Since 1943, the spectrum of this star has served as one of the stable anchor points by which other stars are classified.^[12] It is classified as a Vega-like star that emits excess infrared radiation, indicating it is surrounded by a circumstellar disk.^[13] Fomalhaut, K-type main-sequence star **TW Piscis Austrini**, and M-type, red dwarf star **LP 876-10** constitute a triple system, even though the companions are separated by several degrees.^[14]

Fomalhaut holds a special significance in extrasolar planet research, as it is the center of the first stellar system with an extrasolar planet candidate (designated Fomalhaut b, later named Dagon) imaged at visible wavelengths. The image was published in *Science* in November 2008.^[15] Fomalhaut is the third-brightest star (as viewed from Earth) known to have a planetary system, after the Sun and Pollux.

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Fomalhaut



DSS image of Fomalhaut, field of view 2.7×2.9 degrees.

Credit NASA, ESA, and the Digitized Sky Survey 2.

Acknowledgment: Davide De Martin (ESA/Hubble)

Observation data

	Epoch J2000	Equinox J2000
Constellation	Piscis Austrinus (Fomalhaut A+B), Aquarius (Fomalhaut C)	
Fomalhaut		
Right ascension	22 ^h 57 ^m 39.0465 ^s ^[1]	
Declination	−29° 37′ 20.050″ ^[1]	
Apparent magnitude (V)	1.16 ^[2]	
TW Piscis Austrini		

Capella, which rises at approximately the same time, will stay above the horizon for twenty hours. From England, the star never appears much brighter than magnitude 2.2, due to it being so close to the horizon, and from southern Alaska or Scandinavia, it never rises above the horizon at all.^[28] Fomalhaut can be located in these northern latitudes by the fact that the western (right-hand) side of the Square of Pegasus points to it. Continuing the line from Beta to Alpha Pegasi towards the southern horizon, Fomalhaut is about 45° south of Alpha Pegasi, with no bright stars in between.^[29]

Properties

Fomalhaut is a young star, for many years thought to be only 100 to 300 million years old, with a potential lifespan of a billion years.^{[30][31]} A 2012 study gave a slightly higher age of 440 ± 40 million years.^[7] The surface temperature of the star is around 8,590 K (8,320 °C). Fomalhaut's mass is about 1.92 times that of the Sun, its luminosity is about 16.6 times greater, and its diameter is roughly 1.84 times as large.^[7]

Fomalhaut is slightly metal-deficient compared to the Sun, which means it is composed of a smaller percentage of elements other than hydrogen and helium.^[8] The metallicity is typically determined by measuring the abundance of iron in the photosphere relative to the abundance of hydrogen. A 1997 spectroscopic study measured a value equal to 93% of the Sun's abundance of iron.^{[9][nb 1]} A second 1997 study deduced a value of 78%, by assuming Fomalhaut has the same metallicity as the neighboring star TW Piscis Austrini, which has since been argued to be a physical companion.^{[7][32]} In 2004, a stellar evolutionary model of Fomalhaut yielded a metallicity of 79%.^[8] Finally, in 2008, a spectroscopic measurement gave a significantly lower value of 46%.^[10]

Fomalhaut has been claimed to be one of approximately 16 stars belonging to the Castor Moving Group. This is an association of stars which share a common motion through space, and have been claimed to be physically associated. Other members of this group include Castor and Vega. The moving group has an estimated age of 200 ± 100 million years and originated from the same location.^[30] More recent work has found that purported members of the Castor Moving Group appear to not only have a wide range of ages, but their velocities are too different to have been possibly associated with one another in the distant past.^[14] Hence, "membership" to this dynamical group has no bearing on the age of the Fomalhaut system.^[14]

Debris disks and planet

Fomalhaut is surrounded by several debris disks.

Absolute magnitude (M_V)	7.08 ^[7]
Details	
Fomalhaut	
Mass	1.92 ± 0.02 ^[7] M _☉
Radius	1.842 ± 0.019 ^[7] R _☉
Luminosity	16.63 ± 0.48 ^[7] L _☉
Surface gravity (log g)	4.21 ^[8] cgs
Temperature	8,590 ^[7] K
Metallicity [Fe/H]	−0.03 ^[9] to −0.34 ^[10] dex
Rotational velocity (v sin i)	93 ^[8] km/s
Age	(4.4 ± 0.4) × 10 ^{8[7]} years
TW Piscis Austrini	
Mass	0.725 ± 0.036 ^[5] M _☉
Radius	0.629 ± 0.051 ^[5] R _☉
Luminosity	0.19 ^[7] L _☉
Temperature	4,711 ± 134 ^[5] K
Rotational velocity (v sin i)	2.93 ^[5] km/s
Age	4.4 × 10 ^{8[7]} years
Other designations	
Fomalhaut: α Piscis Austrini, α PsA, Alpha PsA, 24 Piscis Austrini, CPD −30° 6685, FK5 867, GI 881, HD 216956, HIP 113368, HR 8728, SAO 191524	
TW Piscis Austrini: Fomalhaut B, TW PsA, GI 879, HR 8721, CD −32° 17321, HD 216803, LTT 9283, GCTP 5562.00, SAO 214197, CP(D)-32 6550, HIP 113283	

The inner disk is a high-carbon small-grain (10-300 nm) ash disk, clustering at 0.1 AU from the star. Next is a disk of larger particles, with inner edge 0.4-1 AU of the star. The innermost disk is unexplained as yet.^[13]

The outermost disk is at a radial distance of 133 AU (1.99×10^{10} km; 1.24×10^{10} mi), in a toroidal shape with a very sharp inner edge, all inclined 24 degrees from edge-on.^{[34][35]} The dust is distributed in a belt about 25 AU wide. The geometric center of the disk is offset by about 15 AU (2.2×10^9 km; 1.4×10^9 mi) from Fomalhaut.^[36] The disk is sometimes referred to as "Fomalhaut's Kuiper belt". Fomalhaut's dusty disk is believed to be protoplanetary,^[37] and emits considerable infrared radiation. Measurements of Fomalhaut's rotation indicate that the disk is located in the star's equatorial plane, as expected from theories of star and planet formation.^[38]

On November 13, 2008, astronomers announced an object, which they assumed to be an extrasolar planet, orbiting just inside the outer debris ring. This was the first extrasolar orbiting object to be seen with visible light, captured by the Hubble Space Telescope.^[39] A planet's existence had been previously suspected from the sharp, elliptical inner edge of that disk.^[40] The mass of the planet, Fomalhaut b, was estimated to be no more than three times the mass of Jupiter, but at least the mass of Neptune.^[41] There are indications that the orbit is not apsidally aligned with the dust disk, which may indicate that additional planets may be responsible for the dust disk's structure.^[42]

However, M-band images taken from the MMT Observatory put strong limits on the existence of gas giants within 40 AU of the star,^[43] and Spitzer Space Telescope imaging suggested that the object Fomalhaut b was more likely to be a dust cloud.^[44] In 2012, two independent studies confirmed that Fomalhaut b does exist, but it is shrouded by debris, so it may be a gravitationally-bound accumulation of rubble rather than a whole planet.^{[45][46]}

Herschel Space Observatory images of Fomalhaut reveal that a large amount of fluffy micrometer-sized dust is present in the outer dust belt. Because such dust is expected to be blown out of the system by stellar radiation pressure on short timescales, its presence indicates a constant replenishment by collisions of planetesimals. The fluffy morphology of the grains suggests a cometary origin. The collision rate is estimated to be approximately 2000 kilometre-sized comets per day.^[47]

Observations of the star's outer dust ring by the Atacama Large Millimeter Array point to the existence of two planets in the system, neither one at the orbital radius proposed for the HST-discovered Fomalhaut b.^[48]

LP 876-10: Fomalhaut C, 2MASS J22480446-2422075, NLTT 54872, GSC 06964-01226

Database references

SIMBAD	AC (http://simbad.u-strasbg.fr/simbad/sim-id?Ident=**+MAM+1)
	AB (http://simbad.u-strasbg.fr/simbad/sim-id?Ident=**+SHY+106)
	A (Fomalhaut) (http://simbad.u-strasbg.fr/simbad/sim-id?Ident=Fomalhaut)
	B (TW PsA) (http://simbad.u-strasbg.fr/simbad/sim-id?Ident=HD+216803)
	C (LP 876-10) (http://simbad.u-strasbg.fr/simbad/sim-id?Ident=LP+876-10)
	planet b (http://simbad.u-strasbg.fr/simbad/sim-id?Ident=*+alf+PsA+b)
Exoplanet Archive	data (http://exoplanetarchive.ipac.caltech.edu/cgi-bin/DisplayOverview/nph-DisplayOverview?objname=Fomalhaut)
ARICNS	A (Fomalhaut) (http://wwadd.zah.uni-heidelberg.de)

If there are additional planets from 4 to 10 AU, they must be under 20 M_J ; if from 2.5 outward, then 30 M_J .^[49]

rg.de/datenbanken/aricns/cnspages/4c01877.htm)

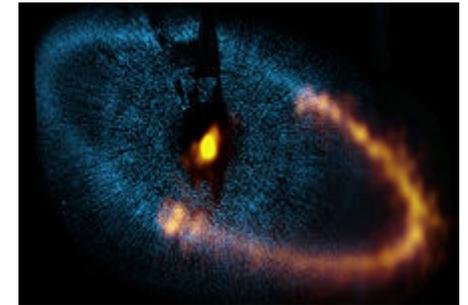
B (TW PsA) (<http://www.add.zah.uni-heidelberg.de/datenbanken/aricns/cnspages/4c01875.htm>)

Extrasolar Planets Encyclopaedia

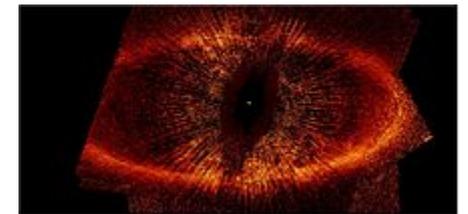
data (<http://exoplanet.eu/star.php?st=Fomalhaut>)



ALMA image of Fomalhaut's Debris Disc.^[33]



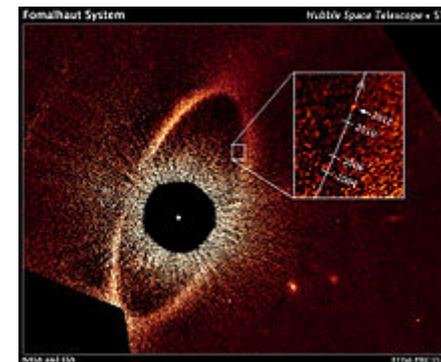
Dust ring around Fomalhaut from the Atacama Large Millimeter/submillimeter Array (ALMA)^[27]



The debris disk around the star

The Fomalhaut planetary system^{[13][50]}

Companion (in order from star)	Mass	Semimajor axis (AU)	Orbital period (years)	Eccentricity	Inclination	Radius
Inner hot disk		0.08–0.11 AU			—	—
Outer hot disk		0.21–0.62 AU or 0.88–1.08 AU			—	—
10 AU belt		8–12 AU			—	—
Interbelt dust disk		35–133 AU			—	—
b (Dagon)	? <i>M</i> _J	177±68	~1700	0.8±0.1	−55°	—
Main belt		133–158 AU			−66.1°	—
Main belt outer halo		158–209 AU			—	—



Debris ring around Fomalhaut showing location of planet Fomalhaut b—imaged by Hubble Space Telescope's coronagraph. (January 8, 2013) (NASA).

Fomalhaut B (TW Piscis Austrini)

Fomalhaut forms a binary star with the K4-type star TW Piscis Austrini (TW PsA), which lies 0.28 parsecs (0.91 light-years) away from Fomalhaut, and its space velocity agrees with that of Fomalhaut within 0.1 ± 0.5 km/s, consistent with being a bound companion. A recent age estimate for TW PsA (400 ± 70 million years) agrees very well with the isochronal age for Fomalhaut (450 ± 40 million years), further arguing for the two stars forming a physical binary.^[7]

The designation TW Piscis Austrini is astronomical nomenclature for a variable star. Fomalhaut B is a flare star of the type known as a BY Draconis variable. It varies slightly in apparent magnitude, ranging from 6.44 to 6.49 over a 10.3 day period. While smaller than the Sun, it is relatively large for a flare star. Most flare stars are red M-type dwarfs.

Fomalhaut C (LP 876-10)

LP 876-10 is also associated with the Fomalhaut system, making it a trinary star. In October 2013, Eric Mamajek and collaborators from the RECONS consortium announced that the previously known high-proper-motion star LP 876-10 had a distance, velocity, and color-magnitude position consistent with being another member of the Fomalhaut system.^[14] LP 876-10 was originally catalogued as a high-proper-motion star by Willem Luyten in his 1979 NLTT catalogue; however, a precise trigonometric parallax and radial velocity was only measured quite recently. LP 876-10 is a red dwarf of spectral type M4V, and located even further from Fomalhaut A than TW PsA—about 5.7° away from Fomalhaut A in the sky, in the neighbouring constellation Aquarius, whereas both Fomalhaut A and TW PsA are located in constellation Piscis Austrinus. Its current separation from Fomalhaut A is about 0.77 parsecs (2.5 light-years), and it is currently located 0.987 parsecs (3.22 light-years) away from TW PsA (Fomalhaut B). LP 876-10 is located well within the tidal radius of the Fomalhaut system, which is 1.9 parsecs (6.2 light-years).^[14]

Although LP 87 6-10 is itself catalogued as a binary star in the Washington Double Star Catalog (called "WSI 138"), there was no sign of a close-in stellar companion in the imaging, spectral, or astrometric data in the Mamajek et al. study.^[14] In December 2013, Kennedy et al. reported the discovery of a cold dusty debris disk associated with Fomalhaut C, using infrared images from the Herschel Space Observatory. Multiple-star systems hosting multiple debris disks are exceedingly rare.^[51]

 The Fomalhaut C planetary system^[51]

Companion (in order from star)	Mass	Semimajor axis (AU)	Orbital period (days)	Eccentricity	Inclination	Radius
Debris disk		~10–<40 AU			—	—

Etymology and cultural significance

Fomalhaut has had various names ascribed to it through time, and has been recognized by many cultures of the northern hemisphere, including the Arabs, Persians, and Chinese. It marked the solstice in 2500 BC. It was also a marker for the worship of Demeter in Eleusis.^[52]

- It was called *Hastorang* by the Persians, one of the four "royal stars".^[19]
- The Latin names are *ōs piscis merīdiāni*, *ōs piscis merīdonālis*, *ōs piscis notii* "the mouth of the Southern Fish".^[19]
- The name *Difda al Auwel* comes from the colloquial Arabic الضفدع الأول *aḍ-ḍifdiʿ al-ʾawwal* "the first frog" (the second frog is Beta Ceti).^[19]
- The Chinese name 北落師門/北落师门 (Mandarin: Běiluòshīmén), meaning *North Gate of the Military Camp*, because this star is marking itself and stands alone in *North Gate of the Military Camp asterism*, Encampment mansion (see: Chinese constellation).^[53] 北落师门 (Běiluòshīmén), westernized into *Pi Lo Sze Mun* in R.H. Allen's work.^[19]
- To the Moporr Aboriginal people of South Australia, it is a masculine being called *Buunjill*.^[54] The Wardaman people of the Northern Territory called Fomalhaut *Menggen* — white cockatoo.^[55]

Fomalhaut/Earthwork B, in Mounds State Park near Anderson, Indiana, lines up with the rising of the star Fomalhaut in the fall months, according to the Indiana Department of Natural Resources. In 1980, astronomer Jack Robinson proposed that the rising azimuth of Fomalhaut was marked by cairn placements at both the Bighorn and Moose Mountain Medicine Wheels in Wyoming, USA and Saskatchewan, Canada, respectively.^[56]

The *New Scientist* magazine termed it the "Great Eye of Sauron", due to its shape and debris ring, when viewed from a distance, bearing similarity to the aforementioned "Eye" in the Peter Jackson *Lord of the Rings* films.^[57]

In Walter Tevis' novel *Steps of the Sun*, Fomalhaut is visited by the protagonist, and two potentially inhabitable planets are found (and described). Parts of Philip K Dick's novel *Lies, Inc* (originally titled *The Unteleported Man*) are set on the fictional planet Fomalhaut IX. Ursula K. Le Guin's first novel *Rocannon's World* is also set on a fictional planet in the Fomalhaut system.

USS *Fomalhaut* (AK-22) was a United States navy amphibious cargo ship.

See also

- [Exoplanet](#)
- [GJ 758](#)
- [HR 8799](#)
- [List of extrasolar planets](#)
- [Direct imaging of extrasolar planets](#)
- [Fomalhaut in fiction](#)
- [2M1207](#)
- [Vega](#)
- [List of star systems within 25–30 light-years](#)

Notes

1. Calculation of [metallicity](#): if $m = [\text{Fe}/\text{H}]$, then the ratio of iron to hydrogen for Fomalhaut divided by the ratio of iron to hydrogen for the Sun is given by 10^m .

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