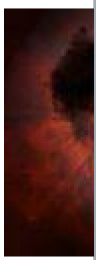
Name	Images		Constellation	Magnitude		Distance	Coordinates		External Links
				Apparent	Absolute		Right Ascension	Declination	
HOPS 383			Orion			1,400 ly (420 pc)	5h 35m 29.81s	−4° 59′ 51.1″	Chandra
			HOPS 383 is a protostar surrounded by a shell of dust. In December 2017, the young protostar underwent an X-Ray flare.						
HH 24-26			Orion			1300 ly	05h 46m 07.34s	−00° 13′ 31.3″	APOD
			HH24-26 is a molecular cloud and star-forming region that contains the Herbig-Haro objects HH 24, HH 25, and HH 26 originating from three protostars, as well as a very high concentration of jets.						
V1331 Cyg			Cygnus			1800 ly	21h 01m 09.210s	+50° 21′ 44.77″	phys.org

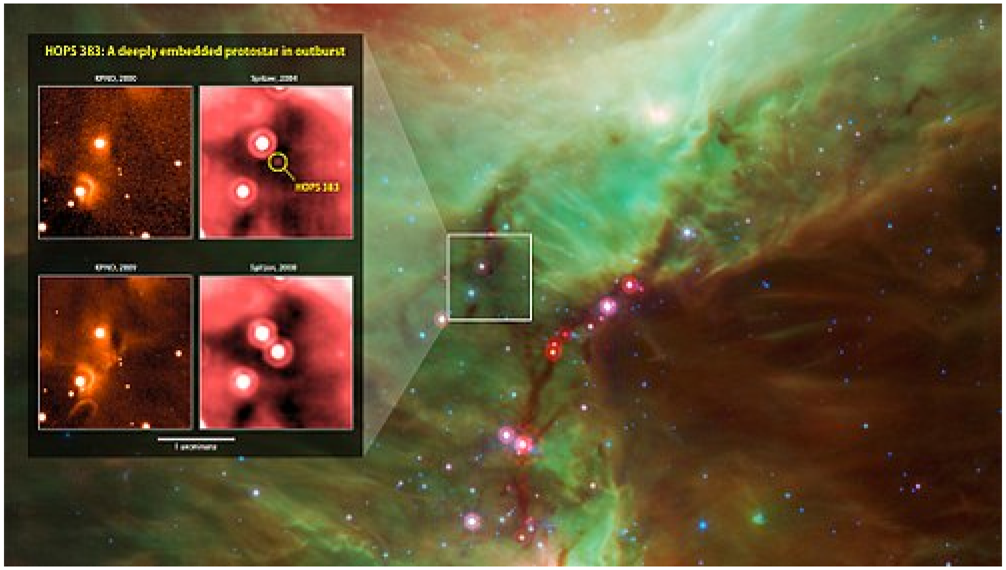
			V1331 Cyg is a young star surrounded by an interesting ring-shaped structure, with an interesting missing arc from the ring.						
HBC 672			Serpens Cauda				18h 29m 56.88s	+01° 14′ 46.34″	NASA
			HBC 672 is a young star surrounded by a planet-forming disk that is moving and warping. The warping may be caused by a planet pulling on the disk.						
Orion Nebula			Orion	+4.0		1,344 ly	05h 35m 17.3s	−05° 23′ 28″	Chandra Hubble
			The Orion Nebula is a star-forming region in Orion.						
Alpha Tauri (Aldebaran)			Taurus			65 ly	04h 35m 55.24s	+16° 30′ 33.49″	
			Alpha Tauri is a K5 star on the red giant branch and is a slow irregular variable of type Lb.						
RR Lyrae			Lyra			841 ly	19h 25m 27.91s	+42° 47′ 03.69″	

			RR Lyrae is a low-mass Population II variable star and is the prototype star for the RR Lyrae class of variables.						
Omicron Ceti (Mira)			Cetus				02h 19m 20.79s	-02° 58′ 39.50″	
			Omicron Ceti is a binary star system consisting of Mira A, a red giant on the asymptotic giant branch and the prototype star for the Mira class of variables, and Mira B, a white dwarf.						
ESO 577-24			Virgo			1400 ly	13h 40m 41.35s	-19° 52′ 55.32″	
			ESO 577-24 is a planetary nebula surrounding the white dwarf Abell 36.						
IC 4593			Hercules			7800 ly	16h 11m 44.55s	+12° 04′ 17.03″	
			IC 4593 is a planetary nebula with a central bubble of ultra-hot gas at a temperature above 1 million K and a central point X-ray source.						
U Antliae			Antlia			910 ly	10h 35m 12.85s	-39° 33′ 45.32″	

			U Antliae is a carbon star and red giant on the asymptotic giant branch surrounded by large shells of dust.						
LP 40-365			Ursa Minor			2061 ly (632 pc)	14h 06m 35.42s	+74° 18′ 58.01″	
			LP 40-365, also known as GD 492, is a white dwarf composed almost entirely of metals that is thought to be the core remnant of a star that has gone supernova. It is moving extremely quickly and will likely escape the Milky Way altogether.						
ASASSN-16oh			Hydrus			200,000 ly	01h 57m 43.80s	-73° 37′ 32.39″	
			ASASSN-16oh is a binary system with a white dwarf accreting mass at the highest rate ever observed, causing it to release "supersoft" X-rays.						
V Sagittae			Sagittarius			7800 ly	20h 20m 14.69s	+21° 06′ 10.44″	
			V Sagittae is a binary system consisting of a main sequence star and a white dwarf. The system has brightened significantly in the past century and is expected to go supernova around the year 2083.						
AR Scorpii			Scorpius			380 ly	16h 21m 47.28s	-22° 53′ 10.39″	

			AR Scorpii is a binary pulsar exhibiting strong variations in optical, ultraviolet, and radio wavelengths (a first for a white dwarf), caused when the pulsar's beam sweeps across its partner red dwarf and the energy is re-emitted.						
SDSS 1035+0551			Sextans				10h 35m 33.02s	+05° 51′ 58.35″	SIMBAD
			SDSS 1035+0551 is a "dead cataclysmic variable," a binary system consisting of a white dwarf accreting mass from a substellar brown dwarf. These systems are thought to be common, but this is the first definite detection of one.						
Tycho's SNR			Cassiopeia				00h 25m 21.5s	+64° 08′ 27″	
			Tycho's SNR is a Type Ia supernova remnant from a supernova observed in 1572 that was caused by a white dwarf accreting mass from its companion red giant.						

HOPS 383

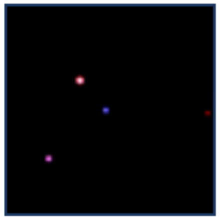


Observation data	
Epoch J2000.0	Equinox J2000.0
Constellation	Orion
Right ascension	$5^h\ 35^m\ 29.81^s$
Declination	−4° 59′ 51.1″

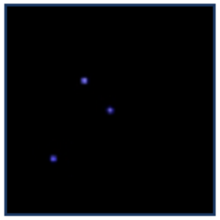
Distance	1,400 ly (420 pc)
Spectral type	Class 0 protostar

2 X-ray, Infrared & Optical Images of HOPS 383

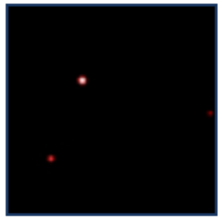
(Credit: X-ray: NASA/CXC/Aix-Marseille University/N. Grosso et al.; Infrared: NOAO/SOAR; Optical: DSS)



X-ray
Jpeg, Tif



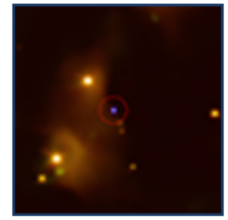
X-ray
High-energy
Jpeg, Tif



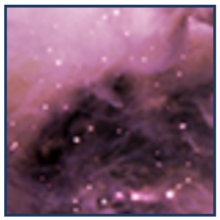
X-ray
Low-energy
Jpeg, Tif

Infrared
Jpeg, Tif

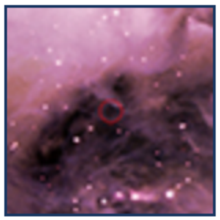
Infrared & X-ray
Jpeg, Tif



Infrared & X-ray
(Labeled)
Jpeg, Tif



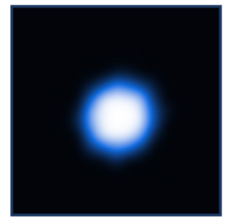
Optical
Jpeg, Tif



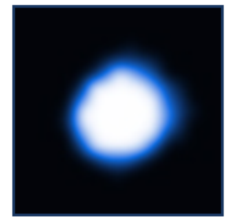
Optical
(Labeled)
Jpeg, Tif

Optical
Jpeg, Tif

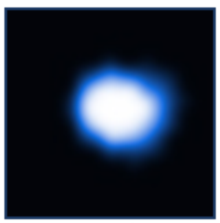
Optical
(Labeled)
Jpeg, Tif



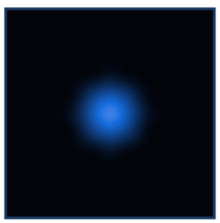
X-ray Flare
Still 1
Jpeg, Tif



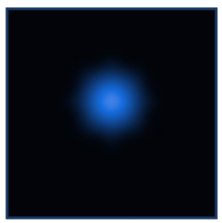
X-ray Flare
Still 2
Jpeg, Tif



X-ray Flare
Still 3
Jpeg, Tif



X-ray Flare
Still 4
Jpeg, Tif



X-ray Flare
Still 5
Jpeg, Tif

Astronomers have reported the first detection of X-rays from the earliest phase of evolution of a star like our Sun. This discovery from NASA's Chandra X-ray Observatory may help answer questions about the Sun and Solar System as they are today. The X-ray flare came from the young "protostar" HOPS 383, about 1,400 light years from Earth, during Chandra observations taken in December 2017, as shown in this series of images. Also shown are the wider field infrared and optical images of the area around HOPS 383.

HOPS 383 is a Class 0 protostar. It is the first class-0 protostar discovered to have had an outburst,[1] and as of 2020, the youngest protostar known to have had an outburst.[1] The protostar was discovered by the Herschel Orion Protostar Survey (HOPS) team

Outburst
HOPS 383 had an outburst between 2004 and 2006 (a "dramatic mid-infrared brightening"); the increase in magnitude was detectable at the 24 μm (35 times increase) and 4.5 μm, and was also detectable at the submillimetre.[3] After 6 years, observations showed no signs of fading.[3]

X-Ray
The Chandra X-Ray Observatory detected an X-ray flare from HOPS 383 in December of 2017.[4] This was the first detection of X-rays from a Class 0 protostar that will evolve into a sun-like star.[4] The flare lasted 3 hours and 20 minutes.[5] It significantly impacted the previously-thought timeline for when such events occur in the evolution of a protostar. Furthermore, it has improved astronomers' understanding of the Sun's earlier evolutionary stages.

HH 24-26

Right ascension	$05^h\ 46^m\ 07.34^s$[1]
Declination	−00° 13′ 31.3″[1]
Distance	1300 ly
Constellation	Orion


HH 24-26 is a molecular cloud and star-forming region containing the Herbig-Haro objects HH 24, HH 25 and HH 26. This region contains the highest concentration of astrophysical jets known anywhere in the sky.[2] The molecular cloud is located about 1400 light-years away in the L1630 dark cloud, which is part of the Orion B molecular cloud in the constellation of Orion.[3][4]

The region contains multiple protostars (two class 0 and one class I) and four more evolved IRAS sources. The three protostars are driving the Herbig-Haro objects in this region.

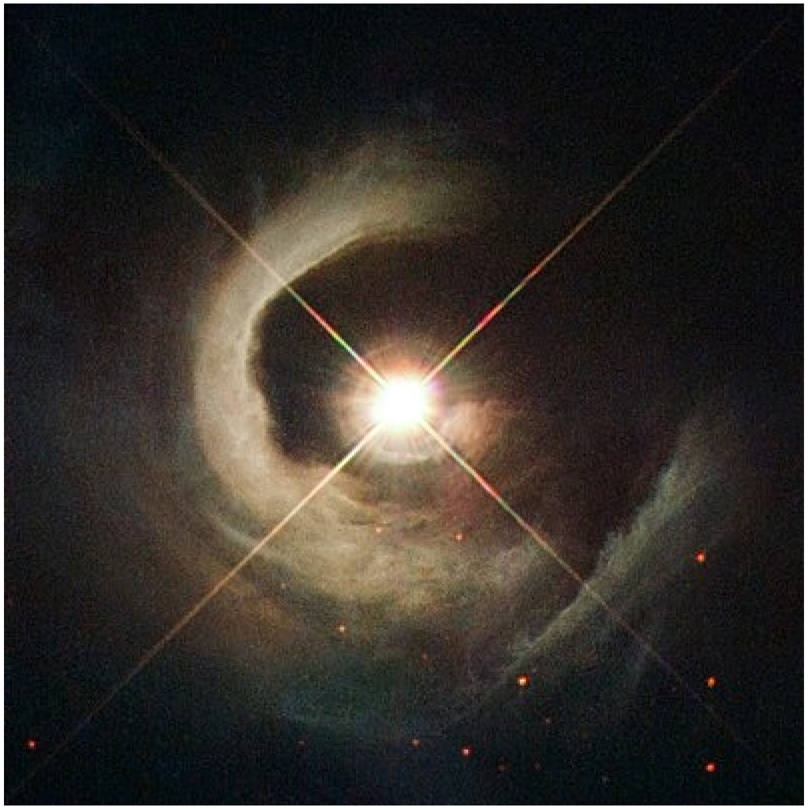
The L1630 dark cloud also contains NGC 2071 and the Flame Nebula. HH 24-26 is located just a few arcminutes south of Messier 78

V1331 Cyg

Observation data	
Epoch J2000	Equinox J2000
Constellation	Cygnus
Right ascension	$21^h\ 01^m\ 09.20684^s$[1]
Declination	+50° 21′ 44.8033″[1]

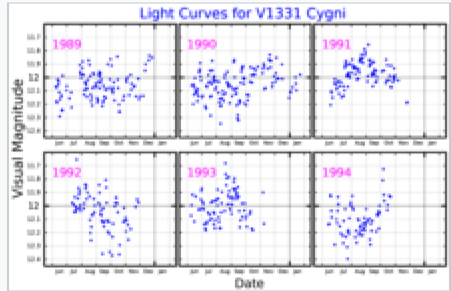
Apparent magnitude (V)	11.99[2]
Characteristics	
Spectral type	G7-K0IV[3]
Astrometry	
Proper motion (μ)	RA: 0.980[1] mas/yr Dec.: −3.783[1] mas/yr
Parallax (π)	1.6760 ± 0.0237[1] mas
Distance	1,950 ± 30 ly (597 ± 8 pc)

Details[3]	
Mass	2.8 $M_\odot$
Radius	5 $R_\odot$
Temperature	5200 K



V1331 Cygni (also known as **V1331 Cyg**) is a young star in the constellation Cygnus. V1331 Cyg is located in the dark nebula LDN 981.[4]

V1331 Cygni is most noted for having an arc-like reflection nebula surrounding it. This circumstellar disc is a great birthplace for young stars, which form in the cloud.[5] V1331 Cygni is heavily obscured by dust, so the properties of the central star are hard to deduce; however, it is estimated to have a radius five times that of the Sun and a mass of 2.8 $M_{\odot}$.[3]



Six visual band light curves for V1331 Cygni, adapted from Mel'nikov (1997)[6]

The General Catalog of Variable Stars classifies V1331 Cygni as an "INST" type variable, meaning a T Tauri star which shows rapid light variations.[7][8] Its visual band brightness varies from magnitude 13.08 to 10.58.[7] It is sometimes classified as a pre-FUOR star.[9] A semi-regular period of ~449 days has been reported.[9] Unlike many T Tauri stars, the mean brightness of V1331 Cygni remains nearly constant over long time periods

HBC 672

NASA's Hubble Space Telescope captured a striking image of a fledgling star's unseen, planet-forming disk casting a huge shadow across a more distant cloud in a star-forming region – like a fly wandering into the beam of a flashlight shining on a wall.

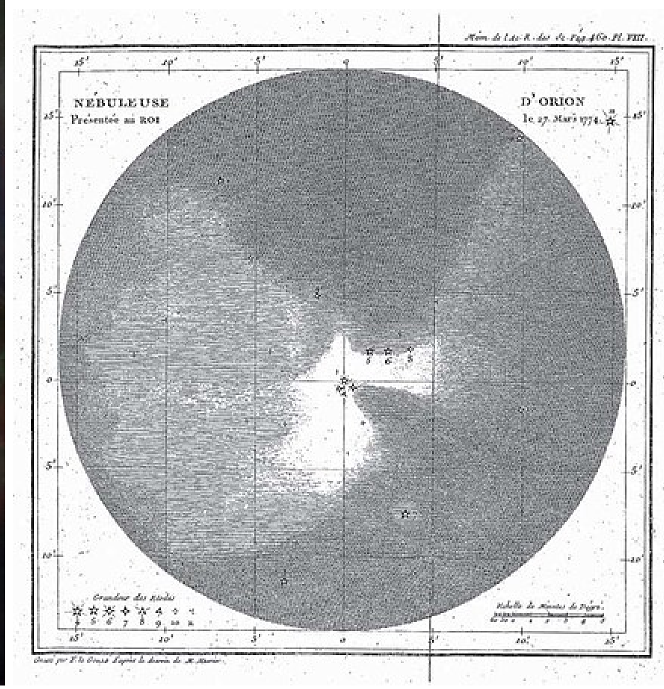
The young star is called HBC 672, and the shadow feature was nicknamed the "Bat Shadow" because it resembles a pair of wings. The nickname turned out to be surprisingly appropriate: Now, the team reports that they see the Bat Shadow flapping!

"The shadow moves. It's flapping like the wings of a bird!" described lead author Klaus Pontoppidan, an astronomer at the Space Telescope Science Institute (STScI) in Baltimore. The phenomenon may be caused by a planet pulling on the disk and warping it. The team witnessed the flapping over 404 days.

But what created the Bat Shadow in the first place?

"You have a star that is surrounded by a disk, and the disk is not like Saturn's rings – it's not flat. It's puffed up. And so that means that if the light from the star goes straight up, it can continue straight up – it's not blocked by anything. But if it tries to go along the plane of the disk, it doesn't get out, and it casts a shadow," explained Pontoppidan.

Orion Nebula



Observation data: J2000 epoch

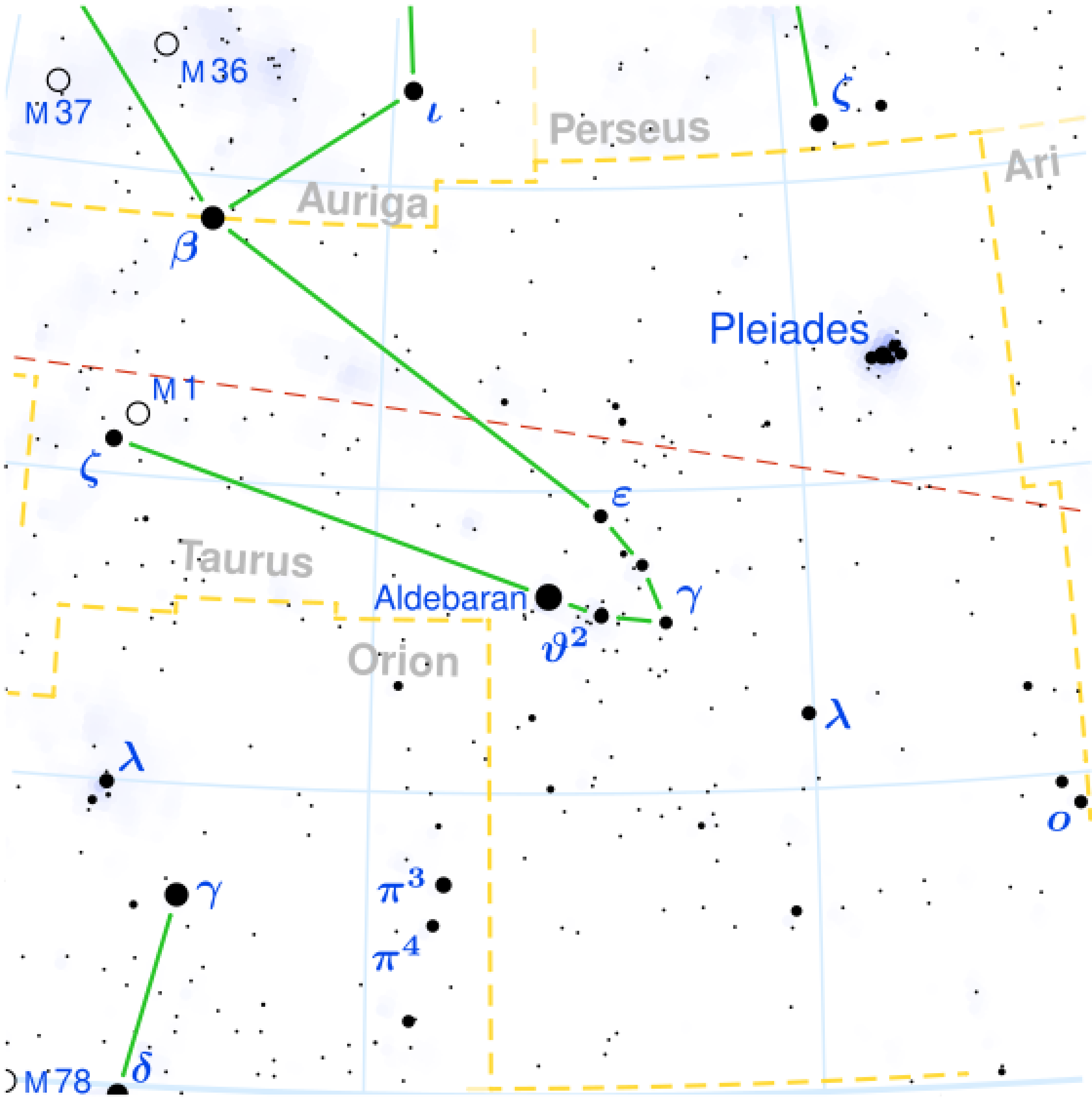
Subtype	Reflection/Emission[2]
Right ascension	$05^h\ 35^m\ 17.3^s$[1]
Declination	−05° 23′ 28″[1]

Distance	1,344±20 ly (412[3] pc)
Apparent magnitude (V)	+4.0[4]
Apparent dimensions (V)	65×60 arcmins[5]
Constellation	Orion
Physical characteristics	
Radius	12[a] ly
Absolute magnitude (V)	—
Notable features	Trapezium cluster

The Orion Nebula (also known as Messier 42, M42, or NGC 1976) is a diffuse nebula situated in the Milky Way, being south of Orion's Belt in the constellation of Orion.[b] It is one of the brightest nebulae and is visible to the naked eye in the night sky. It is 1,344 ± 20 light-years (412.1 ± 6.1 pc) away[3][6] and is the closest region of massive star formation to Earth. The M42 nebula is estimated to be 24 light-years across. It has a mass of about 2,000 times that of the Sun. Older texts frequently refer to the Orion Nebula as the Great Nebula in Orion or the Great Orion Nebula.[7]

The Orion Nebula is one of the most scrutinized and photographed objects in the night sky and is among the most intensely studied celestial features.[8] The nebula has revealed much about the process of how stars and planetary systems are formed from collapsing clouds of gas and dust. Astronomers have directly observed protoplanetary disks and brown dwarfs within the nebula, intense and turbulent motions of the gas, and the photo-ionizing effects of massive nearby stars in the nebula.

Alpha Tauri



M 36
M 37
Perseus
Ari
Auriga
Pleiades
M 1
Taurus
Aldebaran
Orion
M78

Aldebaran /ælˈdɛbərən/, designated α Tauri (Latinized to Alpha Tauri), is a giant star measured to be about 65 light-years from the Sun in the zodiac constellation Taurus. It is the brightest star in Taurus and generally the fourteenth-brightest star in the night sky, though it varies slowly in brightness between magnitude 0.75 and 0.95. Aldebaran is believed to host a planet several times the mass of Jupiter, named Aldebaran b.

Aldebaran is cooler than the Sun with a surface temperature of 3,900 K, but its radius is about 44 times the Sun's, so it is over 400 times as luminous. It spins slowly and takes 520 days to complete a rotation.

The planetary exploration probe Pioneer 10 is heading in the general direction of the star and should make its closest approach in about two million years.

Aldebaran is listed as the spectral standard for type K5+ III stars.[6] Its spectrum shows that it is a giant star that has evolved off the main sequence band of the Hertzsprung–Russell diagram after exhausting the hydrogen at its core. The collapse of the centre of the star into a degenerate helium core has ignited a shell of hydrogen outside the core and Aldebaran is now on the red giant branch (RGB).[5]

The effective temperature of Aldebaran's photosphere is 3,910 K. It has a surface gravity of 1.59 cgs, typical for a giant star, but around 25 times lower than the Earth's and 700 times lower than the Sun's. Its metallicity is about 30% lower than the Sun's.

Measurements by the Hipparcos satellite and other sources put Aldebaran around 65.3 light-years (20.0 parsecs) away.[10] Asteroseismology has determined that it is about 16% more massive than the Sun,[11] yet it shines with 518 times the Sun's luminosity due to the expanded radius. The angular diameter of Aldebaran has been measured many times. The value adopted as part of the Gaia benchmark calibration is 20.580±0.030 mas.[13] It is 44 times the diameter of the Sun, approximately 61 million kilometres.[36]

Aldebaran is a slightly variable star, assigned to the slow irregular type *LB*. The General Catalogue of Variable Stars indicates variation between apparent magnitude 0.75 and 0.95 from historical reports.[4] Modern studies show a smaller amplitude, with some showing almost no variation.[37] Hipparcos photometry shows an amplitude of only about 0.02 magnitudes and a possible period around 18 days.[38] Intensive ground-based photometry showed variations of up to 0.03 magnitudes and a possible period around 91 days.[37] Analysis of observations over a much longer period still find a total amplitude likely to be less than 0.1 magnitudes, and the variation is considered to be irregular.[39]

The photosphere shows abundances of carbon, oxygen, and nitrogen that suggest the giant has gone through its first dredge-up stage—a normal step in the evolution of a star into a red giant during which material from deep within the star is brought up to the surface by convection.[40] With its slow rotation, Aldebaran lacks a dynamo needed to generate a corona and hence is not a source of hard X-ray emission. However, small scale magnetic fields may still be present in the lower atmosphere, resulting from convection turbulence near the surface. The measured strength of the magnetic field on Aldebaran is 0.22 Gauss.[41] Any resulting soft X-ray emissions from this region may be attenuated by the chromosphere, although ultraviolet emission has been detected in the spectrum.[42] The star is currently losing mass at a rate of $(1–1.6) \times 10^{-11}$ $M_{\odot}$ yr^{-1} (about one Earth mass in 300,000 years) with a velocity of 30 km s^{-1}.[40] This stellar wind may be generated by the weak magnetic fields in the lower atmosphere.[42]

Beyond the chromosphere of Aldebaran is an extended molecular outer atmosphere (MOLsphere) where the temperature is cool enough for molecules of gas to form. This region lies at about 2.5 times the radius of the star and has a temperature of about 1,500 K. The spectrum reveals lines of carbon monoxide, water, and titanium oxide.[40] Outside the MOLSphere, the stellar wind continues to expand until it reaches the termination shock boundary with the hot, ionized interstellar medium that dominates the Local Bubble, forming a roughly spherical astrosphere with a radius of around 1,000 AU, centered on Aldebaran

Observation data	
Epoch J2000.0	Equinox J2000.0
Constellation	Taurus
Pronunciation	/ælˈdɛbərən/[1][2]
Right ascension	$04^{h}\ 35^{m}\ 55.23907^{s}$[3]
Declination	+16° 30′ 33.4885″[3]
Apparent magnitude (V)	0.75–0.95[4]
Characteristics	
Evolutionary stage	Red giant branch[5]
Spectral type	K5+ III[6]

Apparent magnitude (J)	−2.095[7]
U−B color index	+1.92[8]
B−V color index	+1.44[8]
Variable type	LB[4]

Astrometry

Radial velocity (R_v)	+54.26±0.03[9] km/s
Proper motion (μ)	RA: 63.45±0.84[3] mas/yr Dec.: −188.94±0.65[3] mas/yr
Parallax (π)	49.97 ± 0.75[10] mas
Distance	65.3 ± 1.0 ly

	(20.0 ± 0.3 pc)
Absolute magnitude **(M_V)**	−0.641±0.034[10]

Details	
Mass	1.16±0.07[11] $M_\odot$
Radius	45.1±0.1[12] $R_\odot$
Luminosity	439±17[13] $L_\odot$
Surface gravity **(log *g*)**	1.45±0.3[14] cgs
Temperature	3,900±50[14] K
Metallicity [Fe/H]	−0.33±0.1[14] dex

Rotation	520 days[12]
Rotational velocity (*v* sin *i*)	3.5±1.5[14] km/s
Age	$6.4^{+1.4}_{-1.1}$[11] Gyr

RR Lyrae

Observation data	
Epoch J2000	Equinox J2000
Constellation	Lyra
Right ascension	**19h 25m 27.91285s**[1]
Declination	**+42° 47′ 03.6942″**[1]

Apparent magnitude (V)	7.195[2] (7.06–8.12)[3]
Characteristics	
Spectral type	A7III - F8III
U−B color index	+0.172[2]
B−V color index	+0.181[2]
Variable type	RR Lyr[4]
Astrometry	
Radial velocity (R_v)	-72.4[5] km/s

Proper motion (μ)	RA: -109.68[1] mas/yr Dec.: -195.75[1] mas/yr
Parallax (π)	3.64 ± 0.23[6] mas
Distance	900 ± 60 ly (270 ± 20 pc)
Absolute magnitude (M_V)	0.600 ± 0.126[7]

Details

Mass	0.65[8] $M_{\odot}$
Radius	5.1 to 5.6[8] $R_{\odot}$

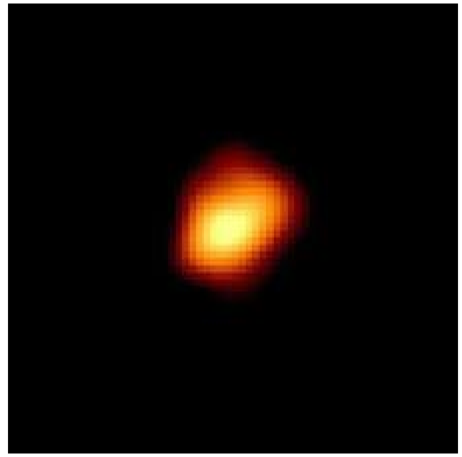
Luminosity	49 ± 5[8] $L_{\odot}$
Surface gravity (log *g*)	2.4 ± 0.2[8] cgs
Temperature	6,125 ± 50[8] K
Metallicity [Fe/H]	−1.16[7] dex

Other designations

RR Lyr, 2MASS J19252793+4247040, NLTT 47799, HD 182989, BD+42°3338, HIP 95497, SAO 48421, LTT 15677

RR Lyrae is a variable star in the Lyra constellation, figuring in its west near to Cygnus.[10] As the brightest star in its class,[11] it became the eponym for the RR Lyrae variable class of stars[3] and it has been extensively studied by astronomers.[7] RR Lyrae variables serve as important standard candles that are used to measure astronomical distances. The period of pulsation of an RR Lyrae variable depends on its mass, luminosity and temperature, while the difference between the measured luminosity and the actual luminosity allows its distance to be determined via the inverse-square law. Hence, understanding the period-luminosity relation for a local set of such stars allows the distance of more distant stars of this type to be determined.[12]

Omicron Ceti (Mira)

Observation data

Epoch J2000.0 Equinox J2000.0

Constellation	Cetus
Right ascension	$02^{h}\ 19^{m}\ 20.79210^{s}$[2]
Declination	−02° 58′ 39.4956″[2]
Apparent magnitude (V)	2.0 *to* 10.1[3]
Characteristics	
Spectral type	M7 IIIe[4] (M5e-M9e[3])
U−B color index	+0.08[5]
B−V color index	+1.53[5]
Variable type	Mira[3]
Astrometry	

Radial velocity (R_V)	+63.8[6] km/s
Proper motion (μ)	RA: +9.33[2] mas/yr Dec.: −237.36[2] mas/yr
Parallax (π)	10.91 ± 1.22[2] mas
Distance	approx. 300 ly (approx. 90 pc)
Absolute magnitude (M_V)	+0.99[7] (variable)

Orbit[8]	
Period (P)	497.88 yr
Semi-major axis (a)	0.8″
Eccentricity (e)	0.16

Inclination (i)	112°
Longitude of the node (Ω)	138.8°
Periastron epoch (T)	2285.75
Argument of periastron (ω) (secondary)	258.3°

Details	
Mass	1.18[9] $M_{\odot}$
Radius	332–402[10] (-541[11]) $R_{\odot}$
Luminosity (bolometric)	8,400–9,360[10] $L_{\odot}$
Temperature	2,918–3,192[10] K

Age	6[9] Gyr

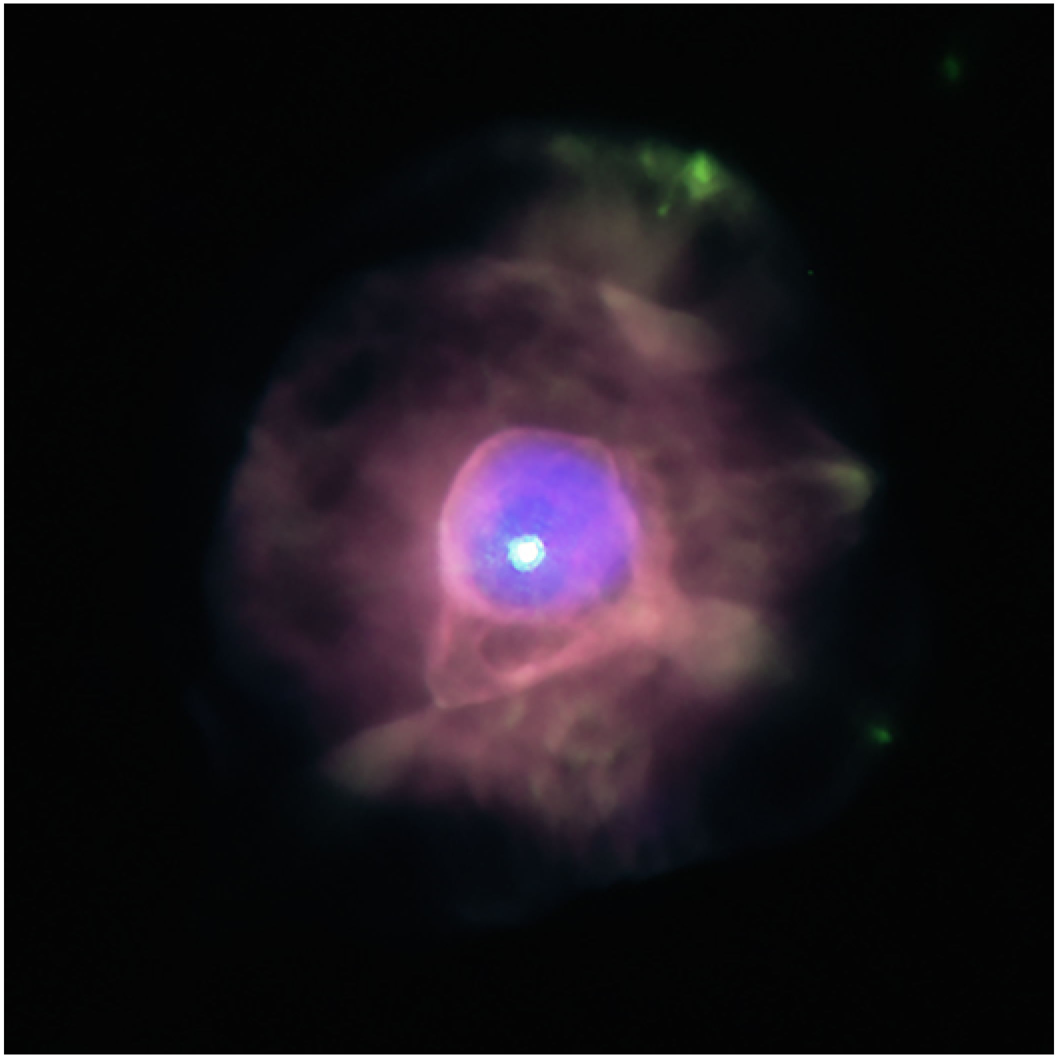
ESO 577-24

Description: Planetary Nebula

Position (J2000): RA 13h 40m 41.37s Dec -19° 53' 6.74"
Constellation: Virgo
Image Credit: ESO
Distance: 1400 light-years
Field of view: 6.76 x 7.36 arcminutes
Orientation: North is -0.0° left of vertical
Image Credit: ESO
Release date: January 22, 2019

The faint, ephemeral glow emanating from the planetary nebula ESO 577-24 persists for only a short time - around 10,000 years, a blink of an eye in astronomical terms. ESO's Very Large Telescope captured this shell of glowing ionized gas - the last breath of the dying star whose simmering remains are visible at the heart of this image. As the gaseous shell of this planetary nebula expands and grows dimmer, it will slowly disappear from sight.

IC 4593



On Earth, amethysts can form when gas bubbles in lava cool under the right conditions. In space, a dying star with a mass similar to the Sun is capable of producing a structure on par with the appeal of these beautiful gems.

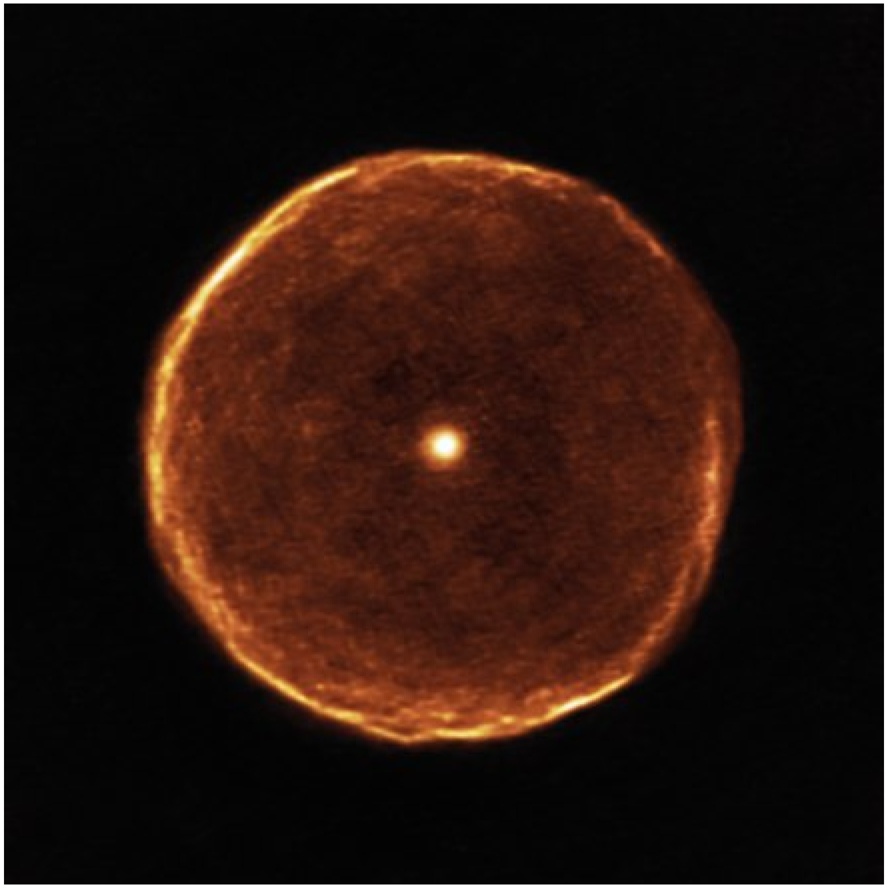
Chandra has found a bubble of ultra-hot gas at the center of a planetary nebula.

Planetary nebulas are formed when Sun-like stars run out of fuel, shedding their outer layers while the star's core shrinks.

This image contains X-rays from Chandra (purple) and optical light data from Hubble (pink and green).

IC 4593 is at a distance of about 7,800 light years from Earth, which is the farthest planetary nebula detected by Chandra.

U Antliae



U Antliae (U Ant) is a variable star in the constellation Antlia. It is a carbon star surrounded by two thin shells of dust.

U Antliae is an extremely red C-type carbon star. These cool stars on the asymptotic giant branch are further reddened by strong mass loss and dust that forms around the star. U Antliae is calculated to have an effective surface temperature of 2,800 K, although the light that reaches us has an appearance more like that from a black body with a temperature of 2,300 K surrounded by dust at a temperature of 72 K.[11] It emits most of its radiation in the infrared and although it is only about 500 times brighter than the sun at visual wavelengths,[9] its bolometric luminosity is 8,000 times higher than the Sun's.[11]

U Antliae is an irregular variable star with an apparent magnitude that varies between 5.27 and 6.04. Approximately 900 light years from Earth, it is surrounded by two shells of dust, thought to have been ejected 14,000 and 10,000 years ago.[13] The exact origin and structure of the shells is uncertain, possibly due to enhanced mass loss during thermal pulses, possibly due to interaction of the stellar wind with interstellar material.

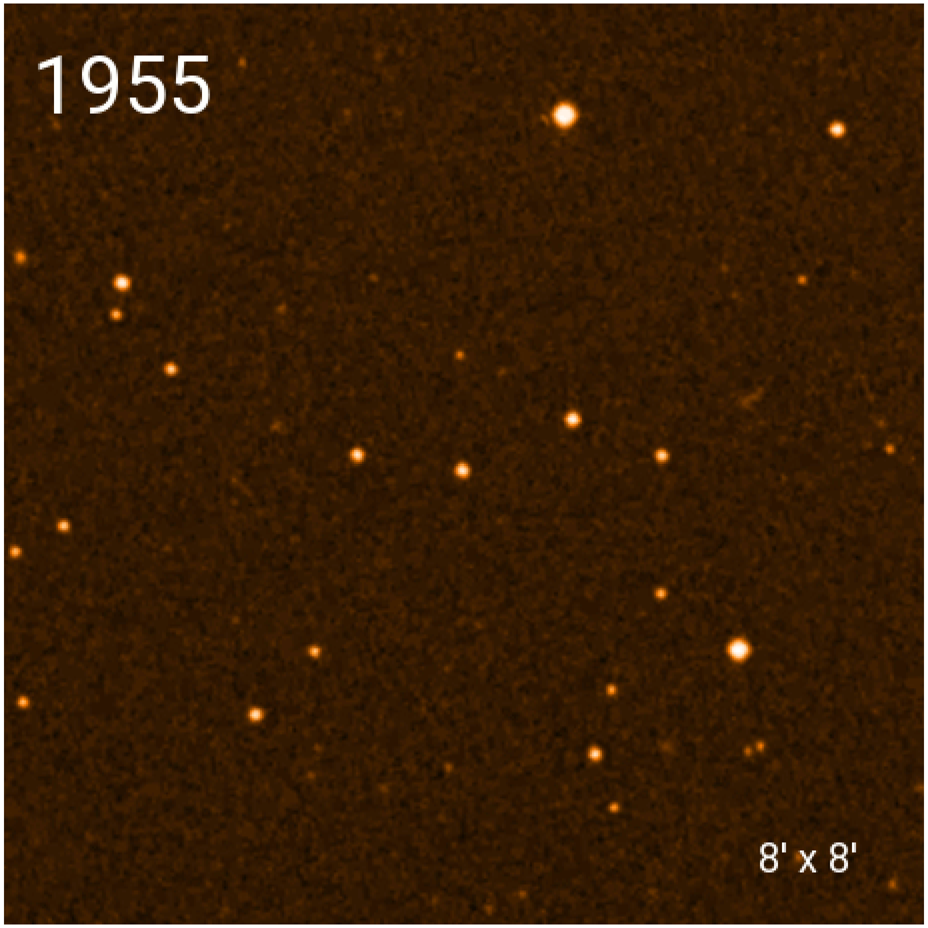
Observation data	
Epoch J2000	**Equinox J2000**
Constellation	Antlia
Right ascension	$10^{h}\ 35^{m}\ 12.852^{s}$[1]
Declination	−39° 33′ 45.32″[1]
Apparent magnitude (V)	5.27 - 6.04[2]
Characteristics	
Evolutionary stage	AGB

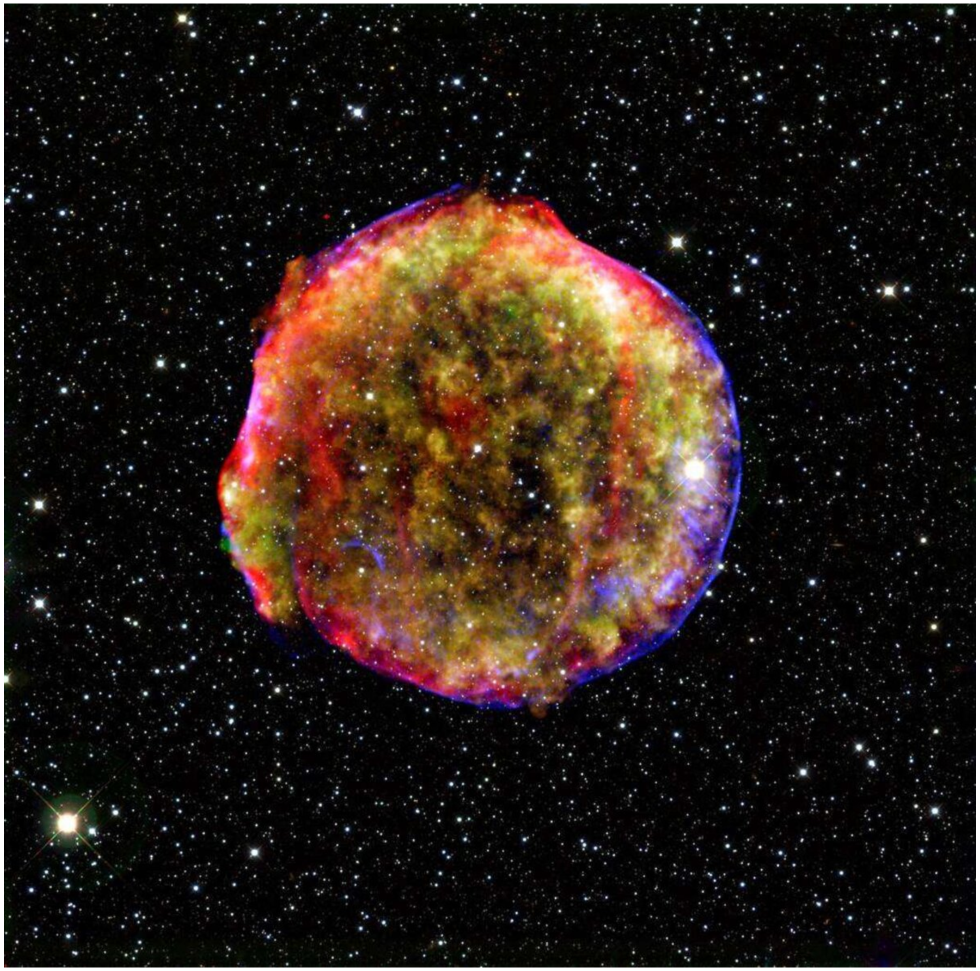
Spectral type	C-N3[3] (C5,3[4])
U−B color index	7.10[5]
B−V color index	2.84[5]
Variable type	LB[6]
Astrometry	
Radial velocity (R_v)	41.00[7] km/s
Proper motion (μ)	RA: −31.372±0.228[8] mas/yr Dec.: 2.371±0.267[8] mas/yr
Parallax (π)	3.5717 ± 0.2043[8] mas
Distance	910 ± 50 ly

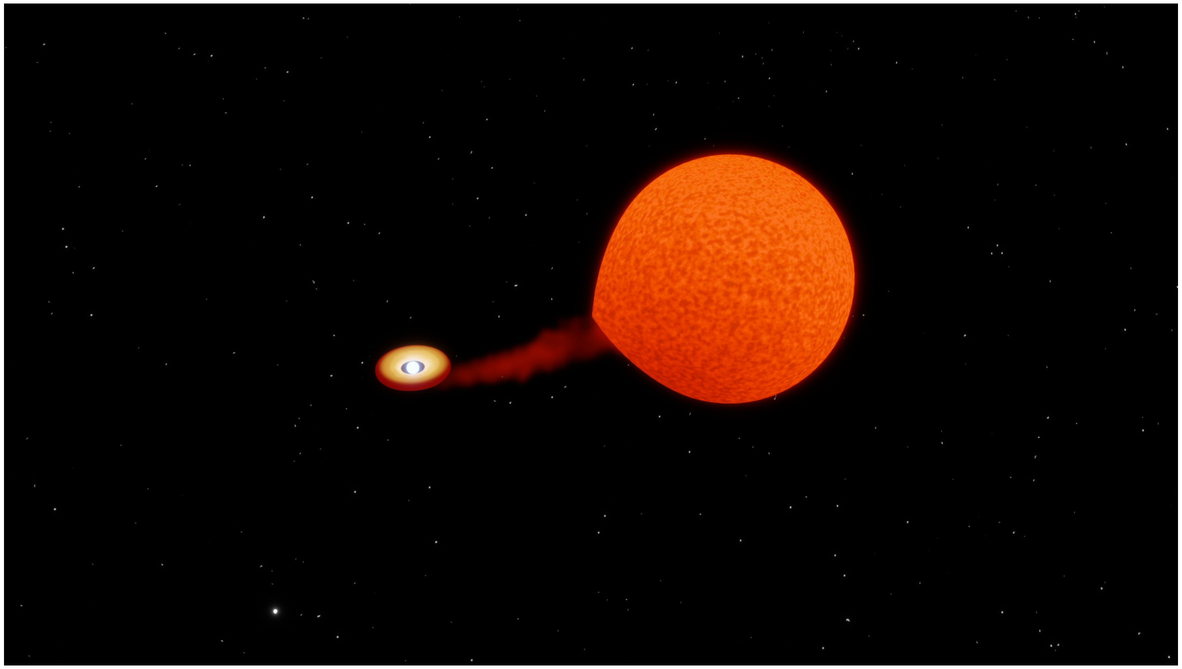
	(280 ± 20 pc)
Absolute magnitude (M_V)	−1.87[9]

Details	
Radius	325[10] $R_\odot$
Luminosity	8,000[11] $L_\odot$
Temperature	2,800[11] K

LP 40-365







LP 40-365 is a low-mass white dwarf star in the constellation Ursa Minor. It travels at high speed through the Milky Way and has a very unusual elemental composition, lacking hydrogen, helium or carbon. It may have been produced in a subluminous Type Iax supernova that failed to destroy its host star totally.[2] [4][5] The "LP" name is derived from the Luyten-Palomar proper motion catalogue in which it appeared in the 1960s.[6] Another catalog name for this star is "GD 492". [3] The star was cataloged as a Giclas object with the designation "GD 492" being assigned by Henry Giclas in 1970

Observation data	
Epoch J2000	Equinox J2000
Constellation	Ursa Minor

Right ascension	$14^h\ 06^m\ 35.45^s$[1]
Declination	+74° 18′ 58.0″[1]
Apparent magnitude (V)	15.51 ± 0.09[2]
Characteristics	
Spectral type	D[2]
Astrometry	
Radial velocity (R_v)	498[2] km/s
Total velocity	~546[2] km/s
Proper motion (μ)	RA: −56 ± 7[2] mas/yr Dec.: 148 ± 7[2] mas/yr

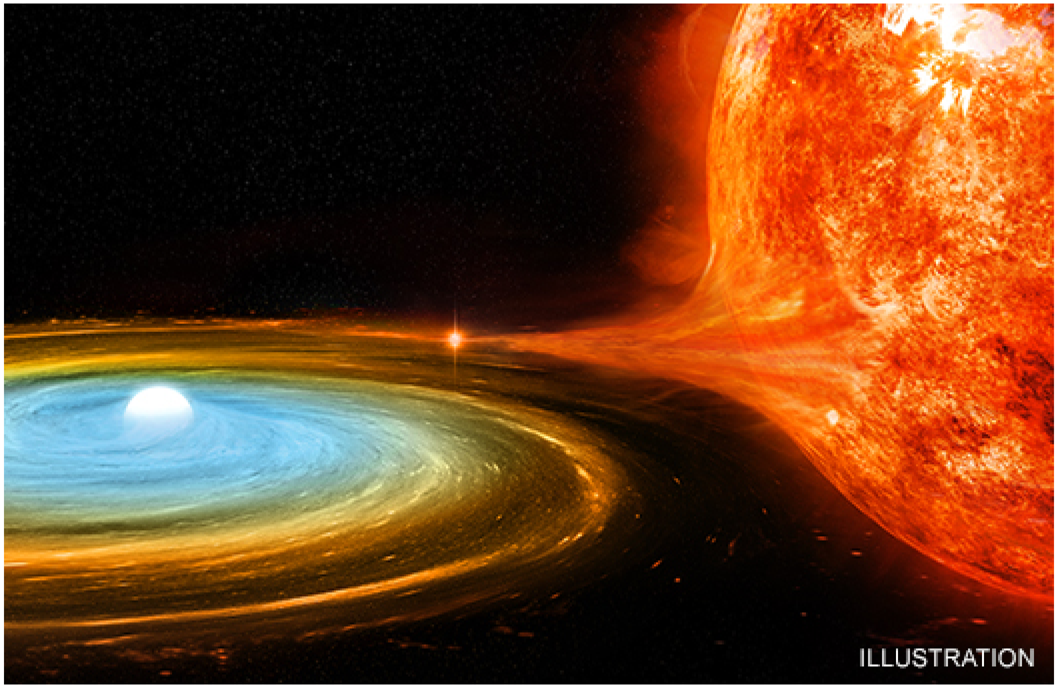
Distance	632[3] pc
Absolute magnitude (M_V)	$8.14^{+0.60}_{-0.90}$[2]

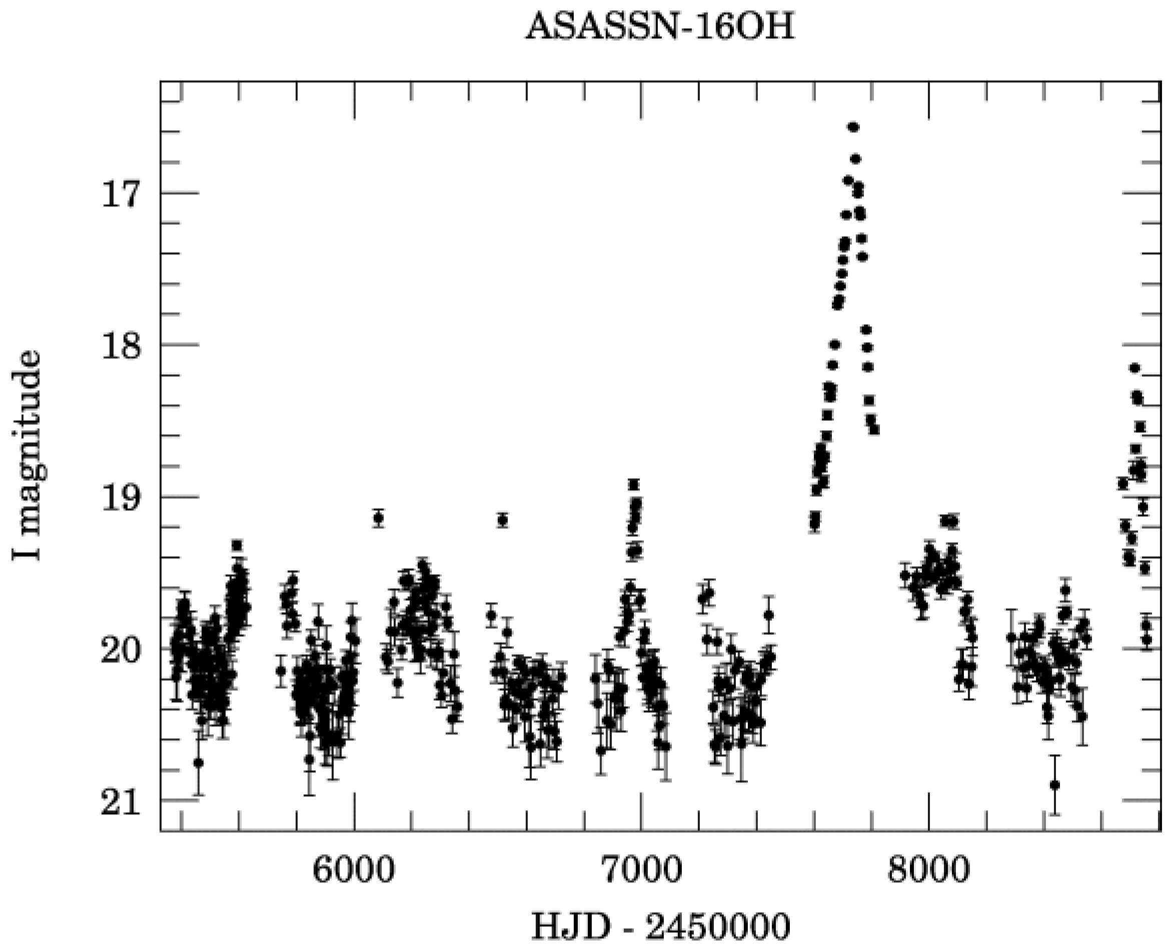
Details[2]

Mass	0.14 ± 0.01 $M_{\odot}$
Radius	$0.078^{+0.040}_{-0.020}$ $R_{\odot}$
Surface gravity (log *g*)	$5.80^{+0.20}_{-0.35}$ cgs
Temperature	10100^{+250}_{-350} K

Rotational velocity (*v* sin *i*)	30.5 ± 2.0 km/s

ASASSN-16oh





Primary Name	asassn-16oh
Binary or Multiple Star System	Yes

Star Type based on Spectral Type	Star
Galaxy	Milky Way
Constellation	Hydrus
Constellation's Main Star	No
Right Ascension (R.A.)	01 57 43.8028271126
Declination (Dec.)	-73 37 32.387271427
Proper Motion Dec.	0.13300 milliarcseconds/year
Proper Motion RA.	4.50700 milliarcseconds/year

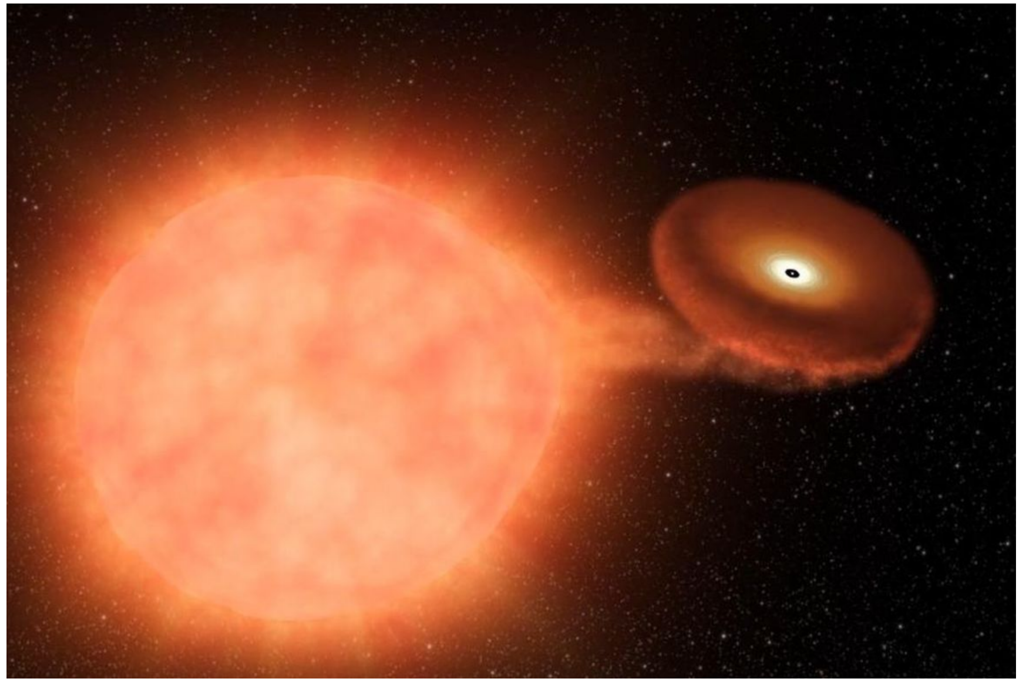
V Sagittae

V Sagittae or **V Sge** is a cataclysmic variable binary star system in the constellation Sagitta that is expected to go nova and briefly become the most luminous point of light in the Milky Way and the brightest stars in our sky around the year 2083.[5][6] The system is composed of a main sequence star of about 3.3 solar masses and a white dwarf of about 0.9 solar masses; the fact that the white dwarf is less massive than its companion is highly unusual,[5] and V Sge is the only super soft X-ray source nonmagnetic cataclysmic variable found so far.

V Sge has brightened by a factor of 10 over the last century, and based on research reported in 2020, it is expected to continue to brighten and briefly become the brightest star in the night sky sometime around 2083, plus or minus about 11 years.[7] Over the final few months and days the pair will coalesce and go nova, eventually becoming a red giant star.

The stars orbit each other about every 0.514 days, and eclipse each other each orbit. The pair is viewed in the late stages of their spiral in. Their orbital period currently decreases by 4.73 * 10^{-10} days per cycle, a rate which will accelerate.

Material from the larger star is accreting onto the white dwarf at an exponentially increasing rate, generating a huge stellar wind. The doubling time for the accretion rate, and hence for the system luminosity, is about 89 years.



Observation data	
Epoch J2000	Equinox J2000
Constellation	Sagitta
Right ascension	$20^h\ 20^m\ 14.691^s$[1]

Declination	+21° 06′ 10.44″[1]
Apparent magnitude (V)	8.6-13.9[2]

Characteristics	
Variable type	eclipsing and cataclysmic[2]

Astrometry	
Proper motion (μ)	RA: −2.052[1] mas/yr Dec.: −6.485[1] mas/yr
Parallax (π)	0.4190 ± 0.0320[1] mas
Distance	7,800 ± 600 ly (2,400 ± 200 pc)

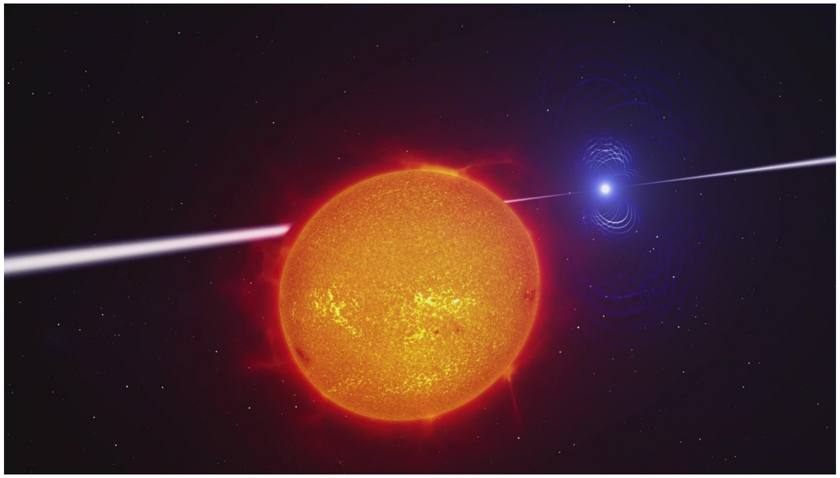
Absolute magnitude (M_V)	−2.2[3]
Orbit[4]	
Semi-major axis (a)	4.36 $R_\odot$
Inclination (i)	71°
Semi-amplitude (K_1) (primary)	320 km/s
Semi-amplitude (K_2) (secondary)	85 km/s
Details	
Mass	0.9[4] $M_\odot$

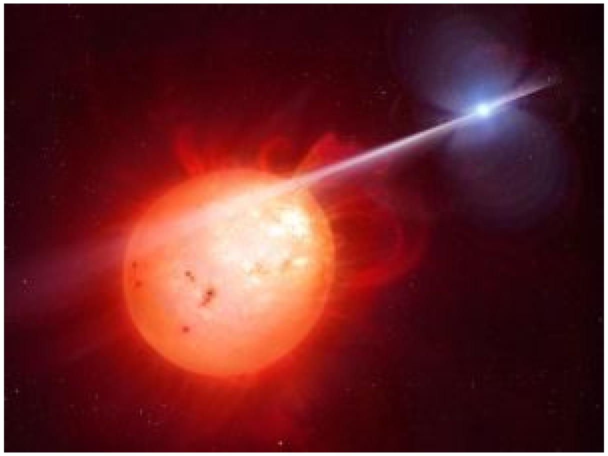
Radius	1.2[4] $R_{\odot}$
Luminosity	30,000[4] $L_{\odot}$
Temperature	70,000[4] K
Mass	3.3[4] $M_{\odot}$
Radius	2.1[4] $R_{\odot}$
Temperature	12,000[4] K

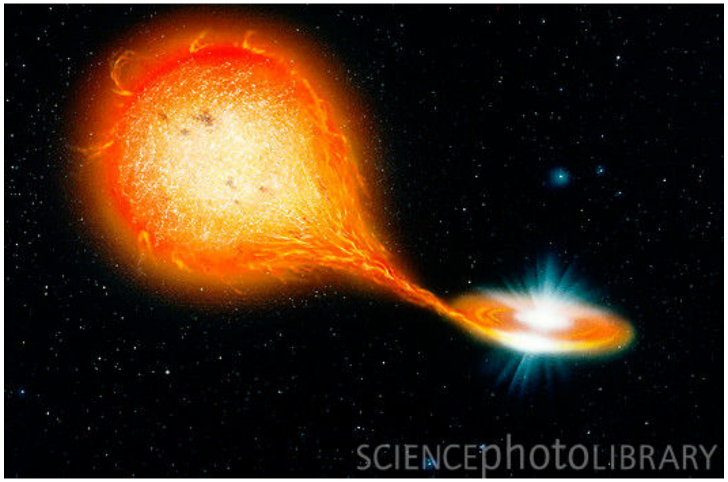
AR Scorpii

AR Scorpii (AR Sco) is a binary pulsar that consists of a white dwarf and a red dwarf.[2] It is located close to the ecliptic plane in the constellation Scorpius. Parallax measurements made by *Gaia* put the system at a distance of about 380 light-years (120 parsecs).[3]

AR Scorpii is the first, and as of 2021, the only[4] "white dwarf-pulsar" to be discovered.[5] Its unusual nature was first noticed by amateur astronomers.[6] The 3.56-hour period in AR Scorpii's light curve caused it to be misclassified as a Delta Scuti variable, but in 2016, this period was found to be the binary orbital period. In addition, the system shows very strong optical, ultraviolet, and radio pulsations originating from the red dwarf with a period of just 1.97 minutes, which is a beat period from the orbital rotation and the white dwarf spin.[2] These pulsations occur when a relativistic beam from the white dwarf sweeps across the red dwarf, which then reprocesses the beam into the observed electromagnetic energy. Although the white dwarf shows evidence of accretion in the past, at present it is not accreting significantly, and the system is powered by the spin-down of the white dwarf.[5][4] The white dwarf's rotation will slow down on a timescale of 10^7 years.[4] It has a radius of about 7×10^3 km,[4] about the same size as Earth.







Observation data	
Epoch J2000	Equinox J2000
Constellation	Scorpius
Right ascension	$16^{h}\ 21^{m}\ 47.28^{s}$[1]
Declination	−22° 53′ 10.3″[1]
Characteristics	
Evolutionary stage	White dwarf
Evolutionary stage	Main sequence
Spectral type	M5[2]

Astrometry	
Proper motion (μ)	RA: 9.707[3] mas/yr Dec.: −51.469[3] mas/yr
Parallax (π)	8.4918 ± 0.0408[3] mas
Distance	384 ± 2 ly (117.8 ± 0.6 pc)

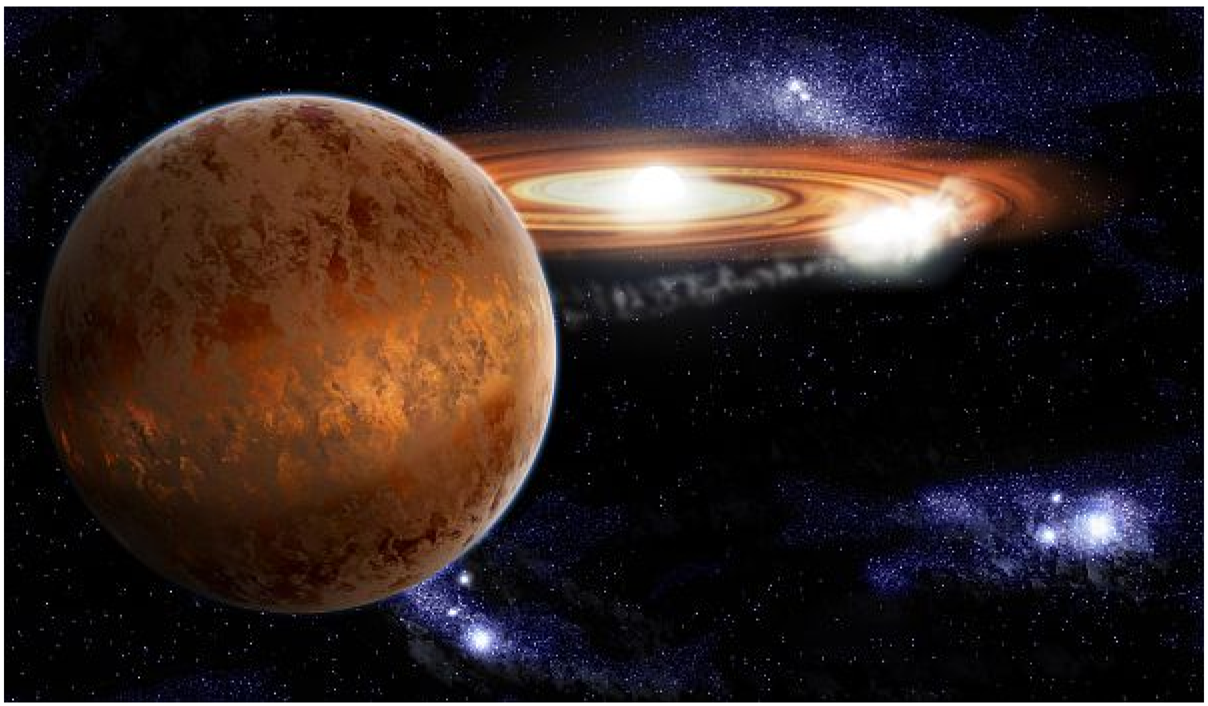
Details	
White dwarf	
Mass	0.8[4] $M_{\odot}$
Radius	0.01[4] $R_{\odot}$

Rotation	1.95[2] minutes

Red dwarf

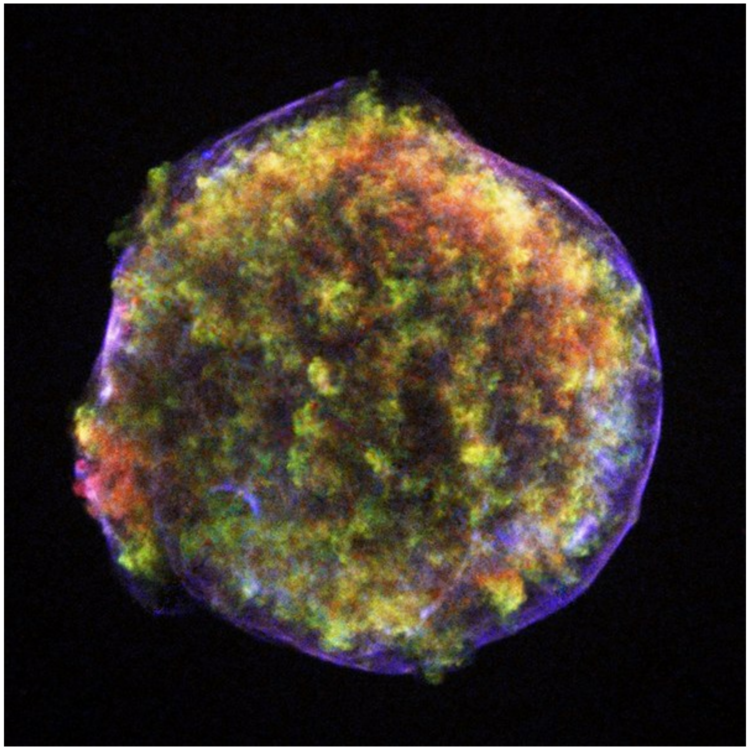
Mass	0.28 - 0.45[2] $M_\odot$

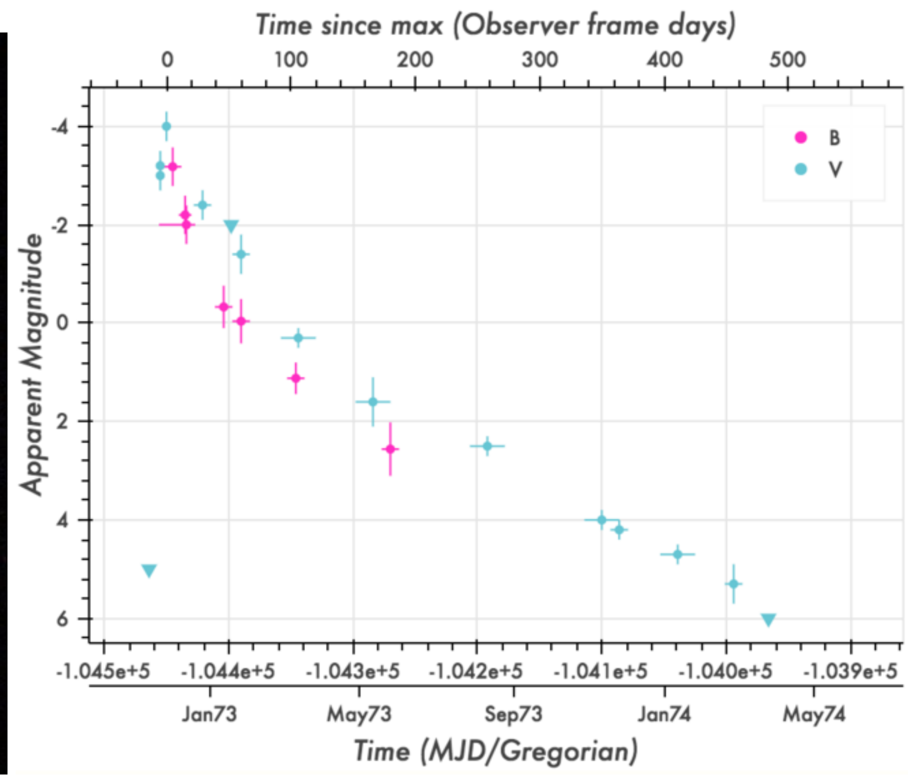
SDSS 1035+0551



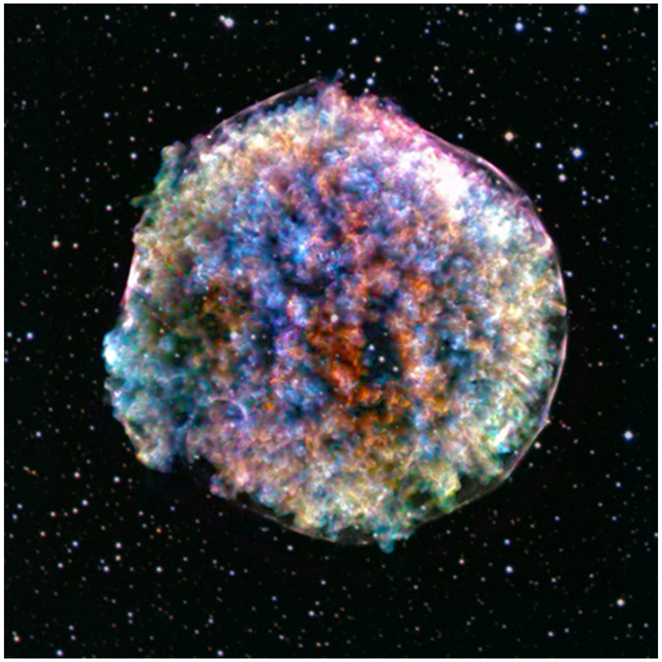
SDSS 1035+0551 is a binary system with a white dwarf and a brown dwarf. An unverified prediction of binary star evolution theory is the existence of a population of white dwarfs accreting from substellar donor stars. Such systems ought to be common, but the difficulty of finding them, combined with the challenge of detecting the donor against the light from accretion, means that no donor star to date has a measured mass below the hydrogen burning limit. In this type of cataclysmic variable system, every kilogram of material that falls onto the white dwarf gains the energy equivalent of a few kilotons of TNT. Much of this energy is released as ultraviolet or x-ray radiation. Many CVs have been identified from this highly variable, short-wavelength light produced by rapid mass transfer onto the white dwarf. However, most CVs should have evolved through this violent phase to become a "dead CV" with a low-mass companion that can support only weak mass transfer. Extensive efforts to confirm this long-standing prediction have failed to identify any CVs that have clearly survived the rapid mass transfer phase of their evolution. SDSS 1035+0551 is the first unambiguous detection of a dead CV from a direct mass measurement of the low-mass companion.

Tycho's SNR





Time since max (Observer frame days)
0
100
200
300
400
500
B
V
Apparent Magnitude
-4
-2
0
2
4
6
-1.045e+5
-1.044e+5
-1.043e+5
-1.042e+5
-1.041e+5
-1.040e+5
-1.039e+5
Jan73
May73
Sep73
Jan74
May74
Time (MJD/Gregorian)



SN 1572 (*Tycho's Supernova*, *Tycho's Nova*), or B Cassiopeiae (B Cas), was a supernova of Type Ia in the constellation Cassiopeia, one of eight supernovae visible to the naked eye in historical records. It appeared in early November 1572 and was independently discovered by many individuals.

Its supernova remnant has been observed optically but was first detected at radio wavelengths; it is often known as 3C 10, a radio-source designation, although increasingly as Tycho's supernova remnant.

The supernova was classified as type I on the basis of its historical light curve soon after type I and type II supernovae were first defined on the basis of their spectra.[9] The X-ray spectrum of the remnant showed that it was almost certainly of type Ia, but its detailed classification within the type Ia class continued to be debated until the spectrum of its light at peak luminosity was measured in a light echo in 2008. This gave final confirmation that it was a normal type Ia.[1]

The classification as a type Ia supernova of normal luminosity allows an accurate measure of the distance to SN 1572. The peak absolute magnitude can be calculated from the B-band decline rate to be −19.0±0.3. Given estimates of the peak apparent magnitude and the known extinction of 1.86±0.2 magnitudes, the distance is 3.8+1.5
−0.9 kpc

Supernova remnant

The distance to the supernova remnant has been estimated to between 2 and 5 kpc (approx. 6,500 and 16,300 light-years), with recent studies suggesting a narrower range of 2.5 and 3 kpc (approx. 8,000 and 9,800 light-years)

Event type	Astronomical radio source, astrophysical X-ray source Type Ia[1]
Date	November 1572
Constellation	Cassiopeia
Right ascension	$0^{h}\ 25.3^{m}$
Declination	+64° 09′

Epoch	?
Galactic coordinates	G.120.1+1.4
Distance	between 8,000 ly (2.5 kpc) and 9,800 ly (3.0 kpc)
Remnant	Nebula
Host	Milky Way
Progenitor	Unknown
Progenitor type	Unknown
Colour (B-V)	~1
Peak apparent magnitude	−4

BRIEF INFO DUMP FOR EACH

Slide 9:
The star in the center of the dark cloud is **V 1331 Cyg** and it is a T Tauri star – a young star that is starting to contract onto the main sequence of the H-R diagram. V 1331 Cyg is special because we are looking at one of its poles. Usually, the view of a young star is obscured by the dust from the circumstellar disc and the envelope that surround it. However, with V1331Cyg we are looking in the exact direction of a jet driven by the star that is clearing the dust and providing an unusual view of the contracting protostar.
Slide 10:
The **Orion Nebula** (M42) is only ~1500 LY away in the constellation of Orion. It is the closest massive star formation region and has been extensively observed in every wavelength for decades. The nebula is home to a wide variety of objects, from the massive stars forming in the open cluster known as the Trapezium, to newly formed protostars and young stellar objects.
Slide 11:
HH 24-26 is a molecular cloud and star-forming region which contains Herbig-Haro objects HH 24, HH 25, and HH 26. The region contains the highest concentration of astrophysical jets yet discovered. The image on the slide is HH 24. When stars form within giant clouds of cool molecular hydrogen, some of the surrounding material collapses under gravity to form a rotating, flattened disk encircling the forming protostar. Gas from the disk rains down onto the protostar and surrounds it. Superheated material spills away and is shot outward from the star in opposite directions along the star's rotation axis. These young stellar jets are ideal targets for NASA's upcoming James Webb Space Telescope, which will have even greater infrared wavelength vision to see deeper into the dust surrounding newly forming stars.
Slide 12:
HOPS 383 is a protostar and NASA’s Chandra X-ray Observatory has made the first detection of X-rays from this earliest phase evolution of a star like our Sun. The X-rays came from a flare emitted by HOPS 383, located about 1,400 light years from Earth in the star-forming region of the Orion Molecular Cloud Complex. Astronomers refer to HOPS 383 as a young "protostar" because it is in the earliest phase of stellar evolution that occurs right after a large cloud of gas and dust has started to collapse. Once it has matured HOPS 383 will have a mass about half that of the Sun. This result is significant because it resets the timeline for when astronomers think

Sun-like stars start blasting X-rays into space. While scientists know that young stars are much more active in X-rays than older ones, they have debated just when X-ray emission begins. The illustrations show HOPS 383 surrounded by a donut-shaped cocoon of material (dark brown) that is falling in towards the central star. Much of the light from the infant star is unable to pierce this material, but X-rays from the flare (blue) can. Infrared light is scattered off the inside of the cocoon (white and yellow).

Slide 13:

The image on the slide is **HBC 672 (Serpens nebula)** and was taken with the NASA/ESA Hubble Space Telescope. It shows the Serpens Nebula, a stellar nursery about 1300 light-years away. Within the nebula, in the upper right of the image, a shadow is created by the protoplanetary disc surrounding the star HBC 672. While the disc of debris is too tiny to be seen even by Hubble, its shadow is projected upon the cloud in which it was formed. In this view, the feature — nicknamed the Bat Shadow — spans approximately 200 times the diameter of our own Solar System.

Slide 14:

Mira (Omicron Ceti) is the protype of the pulsating Mira variable stars, and currently resides in the Mira instability strip on the H-R diagram. Miras are red giants with pulsation periods longer than 100 days and are in the late stages of stellar evolution before collapsing into a white dwarf stellar core and a planetary nebula remnant. The Sun will enter the Mira instability strip as it evolves to the red giant branch of the H-R diagram – its surface eventually extending past the terrestrial planets before collapsing into a white dwarf and planetary nebula. The UV GALEX image on the upper right shows Mira plowing through spacetime and building up a bow wave in front.

Slide 15:

The variable star **RR Lyrae** is the prototype of the pulsating RR Lyrae variable class of stars. They are horizontal branch stars with periods ranging from a few hours to 2 days and have a distinctive light curve as shown on the slide. They occupy the RR Lyrae instability strip on the H-R Diagram. RR Lyrae stars are low metallicity (population II) stars with initial masses similar to the Sun. They become RR Lyrae stars late in the red giant phase, late in the evolution of the star. They are generally found in globular clusters, and in the bulges and halos of galaxies. The slide shows many RR Lyrae stars within a globular cluster. The pulsations are periodic and can be used as standard candles to

measure distances. They exhibit a period-luminosity relationship.
Slide 16:
U Antliae is a carbon star. The image on the slide is from the Atacama Large Millimeter/submillimeter Array (ALMA). Carbon stars have evolved to the asymptotic giant branch of the H-R Diagram and are cool and luminous. U Antliae underwent a period of rapid mass loss which was ejected at high speed and formed the shell surrounding the star. The shell material contains a high percentage of carbon-based chemicals compounds.
Slides 17:
Alpha Tauri (Aldebaran) is a red giant branch star located in the foreground of the Hyades open cluster in the constellation Taurus. Aldebaran will eventually collapse into a white dwarf and a planetary nebula.
Slide 18:
AR Scorpii is a binary system consisting of a white dwarf and a red dwarf. The white dwarf is the only known radio-pulsing white dwarf binary. The system shows emission from radio to X-rays, likely dominated by synchrotron radiation. The mechanism that produces most of this emission remains unclear. Two competing scenarios have been proposed: collimated outflows, and direct interaction between the magnetospheres of the white dwarf and the M star. The latest research suggests that the radio emission in AR Sco is likely produced in the magnetosphere of the M class companion star.
Slide 19:
ASASSN 16-oh is a white dwarf /red giant binary system in the Small Magellanic Cloud. "Supersoft" X-rays have been detected coming from this object, and a combination of X-ray and optical data indicate that the source of the radiation is what may be the fastest-growing white dwarf ever observed. Astronomers have thought that supersoft X-ray emission from white dwarf stars is produced by nuclear fusion in a hot, dense layer of hydrogen and helium nuclei. This volatile material accumulated from the infall of matter from the companion star onto the surface of the white dwarf and led to a nuclear fusion explosion. If nuclear fusion is the cause of the supersoft X-rays from ASASSN-16oh then it should begin with an explosion and the emission should come from the entire surface of the white dwarf. However, the optical light does not increase quickly enough to be caused by an explosion and the Chandra data show that the emission is coming from a region smaller than the surface of the white dwarf. The source is also a hundred times fainter in optical light than white dwarfs known to be undergoing fusion on their

surface. These observations, plus the lack of evidence for gas flowing away from the white dwarf, provide strong arguments against fusion having taken place on the white dwarf.

Slide 20:

V Sagittae is a white dwarf with a main sequence companion similar to the mass of the Sun. As is usual with this type of system, the white dwarf is pulling mass from its companion star into an accretion disk surrounding the white dwarf. What is different about this system is the speed at which the two stars are spiraling inwards towards each other. Eventually the accretion rate will pull mass at extremely high rates onto the white dwarf. All of the mass from the companion star will fall onto the white dwarf, creating a super-massive wind. The resulting thermonuclear explosion will cause V Sag to become the brightest star in the Milky Way Galaxy and is calculated to happen ~2083.

Slide 21:

SDSS 1035+0551 is a binary system with a white dwarf and a brown dwarf. An unverified prediction of binary star evolution theory is the existence of a population of white dwarfs accreting from substellar donor stars. Such systems ought to be common, but the difficulty of finding them, combined with the challenge of detecting the donor against the light from accretion, means that no donor star to date has a measured mass below the hydrogen burning limit. In this type of cataclysmic variable system, every kilogram of material that falls onto the white dwarf gains the energy equivalent of a few kilotons of TNT. Much of this energy is released as ultraviolet or x-ray radiation. Many CVs have been identified from this highly variable, short-wavelength light produced by rapid mass transfer onto the white dwarf. However, most CVs should have evolved through this violent phase to become a "dead CV" with a low-mass companion that can support only weak mass transfer. Extensive efforts to confirm this long-standing prediction have failed to identify any CVs that have clearly survived the rapid mass transfer phase of their evolution. SDSS 1035+0551 is the first unambiguous detection of a dead CV from a direct mass measurement of the low-mass companion.

Slide 22:

DEM L71 is a Type Ia supernova remnant in the Large Magellanic Cloud. DEM L71 presents a textbook example of the double-shock structure expected to develop when a star explodes and ejects matter at high speeds into the surrounding interstellar medium. The expanding ejecta drive an outward-moving shock wave that races ahead of the ejecta into the interstellar gas (bright outer rim). The pressure behind this shock wave drives an inward-moving shock wave that heats the ejecta, seen as the aqua cloud. The clear separation of the shocked matter and the heated ejecta in this Chandra observation allowed astronomers to determine the mass and composition of the ejecta. The computed ejected mass was found to be comparable to the mass of the Sun. This and the X-ray spectrum, which exhibits a high concentration of iron atoms relative to oxygen and silicon, convincingly show that the ejecta are the remains of an exploded white dwarf stellar core when its mass started approaching Chandrashekar's limit. Type Ia supernovas are used as standard candles, as are RR Lyraes, to measure cosmological distances.

Slide 23:

ESO 577-24 is a planetary nebula. Planetary nebulas (PHs) represent the last stages of stellar evolution for low and mid-mass main sequence stars with initial masses less than ~8 solar masses. Mira variable stars transitioning to the red giant branch pulsate as heavier and heavier atomic nuclei and created and consumed. The creation of carbon is the last fusion product; the star begins its final collapse leaving behind a white dwarf and a planetary nebula. ESO 577-24 shows how tenuous these objects are; these nebulas continue to expand into the interstellar medium, getting fainter and fainter and becoming too faint to detect after ~50,000 years. The white dwarf core will continue to lose energy before turning into a black dwarf over tens to hundreds of billions of years.

Slide 24:

Tycho's SNR is a Type Ia supernova remnant, resulting from the thermonuclear destruction of a white dwarf. Observations indicate that the Kepler event was triggered by an interaction between a white dwarf and a read giant star – and not the merger of two white dwarfs. Observational data from a shadow within the remnant las located the probable runaway companion star which is moving through space three times the speed of the other stars in its neighborhood.

Slide 25:

LP 40-365 is a white dwarf that is moving through the galaxy at a high rate of speed ~500-800 km/s. LP 40-365 contains an unusual collection of elements and research indicates that it is possible that it avoided destruction during the thermonuclear explosion and survived. Both the surface gravity and temperature are low for a white dwarf, suggesting an unusually low mass – which could indicate a partially destroyed white dwarf.

Slide 26:

IC 4593 is a planetary nebula. This composite Chandra X-ray and Hubble optical image shows a bubble of gas heated to more than a million degrees. IC 4593 is small compared to the general population of planetary nebulas, and at 78,000 LY away, the furthest planetary nebula imaged by Chandra.