

= Serpens =

Serpens ( " the Serpent " , Greek ????? ) is a constellation of the northern hemisphere . One of the 48 constellations listed by the 2nd @-@ century astronomer Ptolemy , it remains one of the 88 modern constellations defined by the International Astronomical Union . It is unique among the modern constellations in being split into two non @-@ contiguous parts , Serpens Caput ( Serpent Head ) to the west and Serpens Cauda ( Serpent Tail ) to the east . Between these two halves lies the constellation of Ophiuchus , the " Serpent @-@ Bearer " . In figurative representations , the body of the serpent is represented as passing behind Ophiuchus between Mu Serpentis in Serpens Caput and Nu Serpentis in Serpens Cauda .

The brightest star in Serpens is the red giant star Alpha Serpentis , or Unukalhai , in Serpens Caput , with an apparent magnitude of 2 @. @ 63 . Also located in Serpens Caput are the naked @-@ eye globular cluster Messier 5 and the naked @-@ eye variables R Serpentis and Tau4 Serpentis . Notable extragalactic objects include Seyfert 's Sextet , one of the densest galaxy clusters known ; Arp 220 , the prototypical ultraluminous infrared galaxy ; and Hoag 's Object , the most famous of the very rare class of galaxies known as ring galaxies .

Part of the Milky Way 's galactic plane passes through Serpens Cauda , which is therefore rich in galactic deep @-@ sky objects , such as the Eagle Nebula ( IC 4703 ) and its associated star cluster Messier 16 . The nebula measures 70 light @-@ years by 50 light @-@ years and contains the Pillars of Creation , three dust clouds that became famous for the image taken by the Hubble Space Telescope . Other striking objects include the Red Square Nebula , one of the few objects in astronomy to take on a square shape ; and Westerhout 40 , a massive nearby star @-@ forming region consisting of a molecular cloud and an H II region .

= = History = =

In Greek mythology , Serpens represents a snake held by the healer Asclepius . Represented in the sky by the constellation Ophiuchus , Asclepius once killed a snake , but the animal was subsequently resurrected after a second snake placed a revival herb on it before its death . As snakes shed their skin every year , they were known as the symbol of rebirth in ancient Greek society , and legend says Asclepius would revive dead humans using the same technique he witnessed . Although this is likely the logic for Serpens ' presence with Ophiuchus , the true reason is still not fully known . Sometimes , Serpens was depicted as coiling around Ophiuchus , but the majority of atlases showed Serpens passing either behind Ophiuchus ' body or between his legs .

In some ancient atlases , the constellations Serpens and Ophiuchus were depicted as two separate constellations , although more often they were shown as a single constellation . One notable figure to depict Serpens separately was Johann Bayer ; thus , Serpens ' stars are cataloged with separate Bayer designations from those of Ophiuchus . When Eugène Delporte established modern constellation boundaries in the 1920s , he elected to depict the two separately . However , this posed the problem of how to disentangle the two constellations , with Delporte deciding to split Serpens into two areas ? the head and the tail ? separated by the continuous Ophiuchus . These two areas became known as Serpens Caput and Serpens Cauda , caput being the Latin word for head and cauda the Latin word for tail .

In Chinese astronomy , most of the stars of Serpens represented part of a wall surrounding a marketplace , known as Tianshi , which was in Ophiuchus and part of Hercules . Serpens also contains a few Chinese constellations . Two stars in the tail represented part of Shilou , the tower with the market office . Another star in the tail represented Liesi , jewel shops . One star in the head ( Mu Serpentis ) marked Tianru , the crown prince 's wet nurse , or sometimes rain .

There were two " serpent " constellations in Babylonian astronomy , known as Mu??u??u and Ba?mu . It appears that Mu??u??u was depicted as a hybrid of a dragon , a lion and a bird , and loosely corresponded to Hydra . Ba?mu was a horned serpent ( c.f. Ningishzida ) and roughly corresponds to the ????? constellation of Eudoxus of Cnidus on which the ????? ( Serpens ) of Ptolemy is based .

## == Characteristics ==

Serpens is the only one of the 88 modern constellations to be split into two disconnected regions in the sky : Serpens Caput ( the head ) and Serpens Cauda ( the tail ) . The constellation is also unusual in that it depends on another constellation for context ; specifically , it is being held by the Serpent Bearer Ophiuchus .

Serpens Caput is bordered by Libra to the south , Virgo and Boötes to the east , Corona Borealis to the north , and Ophiuchus and Hercules to the west ; Serpens Cauda is bordered by Sagittarius to the south , Scutum and Aquila to the east , and Ophiuchus to the north and west . Covering 636 @.@ 9 square degrees total , it ranks 23rd of the 88 constellations in size . It appears prominently in both the northern and southern skies during the Northern Hemisphere 's summer . Its main asterism consists of 11 stars , and 108 stars in total are brighter than magnitude 6 @.@ 5 , the traditional limit for naked @-@ eye visibility .

Serpens Caput 's boundaries , as set by Eugène Delporte in 1930 , are defined by a 15 @-@ sided polygon , while Serpens Cauda 's are defined by a 25 @-@ sided polygon . In the equatorial coordinate system , the right ascension coordinates of Serpens Caput 's borders lie between 15h 10.4m and 16h 22.5m , while the declination coordinates are between 25 @.@ 66 ° and ? 03 @.@ 72 ° . Serpens Cauda 's boundaries lie between right ascensions of 17h 16.9m and 18h 58.3m and declinations of 06 @.@ 42 ° and ? 16 @.@ 14 ° . The International Astronomical Union ( IAU ) adopted the three @-@ letter abbreviation " Ser " for the constellation in 1922 .

## == Notable features ==

### == Stars ==

#### ==== Head stars ====

Marking the heart of the serpent is the constellation 's brightest star , Alpha Serpentis . Traditionally called Unukalhai , is a red giant of spectral type K2III located approximately 23 parsecs distant with a visual magnitude of 2 @.@ 630 ± 0 @.@ 009 , meaning it can easily be seen with the naked eye even in areas with substantial light pollution . A faint companion is in orbit around the red giant star , although it is not visible to the naked eye . Situated near Alpha is Lambda Serpentis , a magnitude 4 @.@ 42 ± 0 @.@ 05 star rather similar to the Sun positioned only 12 parsecs away . Another solar analog in Serpens is the primary of Psi Serpentis , a binary star located slightly further away at approximately 14 parsecs .

Beta , Gamma , and Iota Serpentis form a distinctive triangular shape marking the head of the snake , with Kappa Serpentis being roughly midway between Gamma and Iota . The brightest of the four with an apparent magnitude of roughly 3 @.@ 67 , Beta Serpentis is a white main @-@ sequence star roughly 160 parsecs distant . It is likely that a nearby 10th @-@ magnitude star is physically associated with Beta , although it is not certain . The Mira variable R Serpentis , situated between Beta and Gamma , is visible to the naked eye at its maximum of 5th @-@ magnitude , but , typical of Mira variables , it can fade to below magnitude 14 . Gamma Serpentis itself is an F @-@ type subgiant located only 11 parsecs distant and thus is quite bright , being of magnitude 3 @.@ 84 ± 0 @.@ 05 . The star is known to show solar @-@ like oscillations .

Delta Serpentis , forming part of the body of the snake between the heart and the head , is a multiple star system positioned around 70 parsecs from Earth . Consisting of four stars , the system has a total apparent magnitude of 3 @.@ 79 as viewed from Earth , although two of the stars , with a combined apparent magnitude of 3 @.@ 80 , provide nearly all the light . The primary , a white subgiant , is a Delta Scuti variable with an average apparent magnitude of 4 @.@ 23 . Positioned very near Delta , both in the night sky and likely in actual space at an estimated distance of around

70 parsecs , is the barium star 16 Serpentis . Another notable variable star visible to the naked eye is Chi Serpentis , an Alpha<sup>2</sup> Canum Venaticorum variable situated midway between Delta and Beta which varies from its median brightness of 5 @. @ 33 by 0 @. @ 03 magnitudes over a period of approximately 1 @. @ 5 days .

The two stars in Serpens Caput that form part of the Snake 's body below the heart are Epsilon and Mu Serpentis , both third @-@ magnitude A @-@ type main @-@ sequence stars . Both have a peculiarity : Epsilon is an Am star , while Mu is a binary . Located slightly northwest of Mu is 36 Serpentis , another A @-@ type main @-@ sequence star . This star also has a peculiarity ; it is a binary with the primary component being a Lambda Boötis star , meaning that it has solar @-@ like amounts of carbon , nitrogen , and oxygen , while containing very low amounts of iron peak elements . 25 Serpentis , positioned a few degrees northeast of Mu Serpentis , is a spectroscopic binary consisting of a hot B @-@ type giant and an A @-@ type main @-@ sequence star . The primary is a slowly pulsating B star , which causes the system to vary by 0 @. @ 03 magnitudes .

Serpens Caput contains many RR Lyrae variables , although most are too faint to be seen without professional photography . The brightest is VY Serpentis , only of 10th magnitude . This star 's period has been increasing by approximately 1 @. @ 2 seconds per century . A variable star of a different kind is Tau4 Serpentis , a cool red giant that pulsates between magnitudes 5 @. @ 89 and 7 @. @ 07 in 87 days . This star has been found to display an inverse P Cygni profile , where cold infalling gas on to the star creates redshifted hydrogen absorption lines next to the normal emission lines .

Several stars in Serpens have been found to have planets . The brightest , Omega Serpentis , located between Epsilon and Mu , is an orange giant with a planet of approximately 1 @. @ 7 Jupiter @-@ masses . NN Serpentis , an eclipsing post @-@ common @-@ envelope binary consisting of a white dwarf and a red dwarf , is very likely to have two planets causing variations in the period of the eclipses . Although it does not have a planet , the solar analog HD 137510 has been found to have a brown dwarf companion within the brown @-@ dwarf desert .

PSR B1534 + 11 is a system consisting of two neutron stars orbiting each other , one of which is a pulsar with a period of 37 @. @ 9 milliseconds . Situated approximately 1000 parsecs distant , the system was used to test Albert Einstein 's theory of general relativity , validating the system 's relativistic parameters to within 0 @. @ 2 % of values predicted by the theory . The X @-@ ray emission from the system has been found to be present when the non @-@ pulsar star intersects the equatorial pulsar wind of the pulsar , and the system 's orbit has been found to vary slightly .

== == Tail stars == ==

The brightest star in the tail , Eta Serpentis , is similar to Alpha Serpentis ' primary in that it is a red giant of spectral class K. This star , however , is known to exhibit solar @-@ like oscillations over a period of approximately 2 @. @ 16 hours . The other two stars in Serpens Cauda forming its asterism are Theta and Xi Serpentis . Xi , where the asterism crosses over to Mu Serpentis in the head , is a triple star system located approximately 105 parsecs away . Two of the stars , with a combined apparent magnitude of around 3 @. @ 5 , form a spectroscopic binary with an angular separation of only 2 @. @ 2 milliarcseconds , and thus cannot be resolved with modern equipment . The primary is a white giant with an excess of strontium . Theta , forming the tip of the tail , is also a multiple system , consisting of two A @-@ type main @-@ sequence stars with a combined apparent magnitude of around 4 @. @ 1 separated by almost half an arcminute .

Lying near the boundary with Ophiuchus are Zeta , Nu , and Omicron Serpentis . All three are 4th @-@ magnitude main @-@ sequence stars , with Nu and Omicron being of spectral type A and Zeta being of spectral type F. Nu is a binary star with a 9th @-@ magnitude companion , while Omicron is a Delta Scuti variable with amplitude variations of 0 @. @ 01 magnitudes . In 1909 , the symbiotic nova RT Serpentis appeared near Omicron , although it only reached a maximum magnitude of 10 .

The star system 59 Serpentis , also known as d Serpentis , is a triple star system consisting of a spectroscopic binary containing an A @-@ type star and an orange giant and an orange giant

secondary . The system shows irregular variations in brightness between magnitudes 5 @. @ 17 and 5 @. @ 2 . In 1970 , the nova FH Serpentis appeared just slightly north of 59 Serpentis , reaching a maximum brightness of 4 @. @ 5 . Also near 59 Serpentis in the Serpens Cloud are several Orion variables . MWC 297 is a Herbig Be star that in 1994 exhibited a large X @-@ ray flare and increased in X @-@ ray luminosity by five times before returning to the quiescent state . The star also appears to possess a circumstellar disk . Another Orion variable in the region is VV Serpentis , a Herbig Ae star that has been found to exhibit Delta Scuti pulsations . VV Serpentis has also , like MWC 297 , been found to have a dusty disk surrounding it , and is also a UX Orionis star , meaning that it shows irregular variations in its brightness .

The star HR 6958 , also known as MV Serpentis , is an Alpha2 Canum Venaticorum variable that is faintly visible to the naked eye . The star 's metal abundance is ten times higher than the Sun for most metals at the iron peak and up to 1 @, @ 000 times more for heavier elements . It has also been found to contain excess silicon . Barely visible to the naked eye is HD 172365 , a likely post @-@ blue straggler in the open cluster IC 4756 that contains a large excess of lithium . HD 172189 , also located in IC 4756 , is an Algol variable eclipsing binary with a 5 @. @ 70 day period . The primary star in the system is also a Delta Scuti variable , undergoing multiple pulsation frequencies , which , combined with the eclipses , causes the system to vary by around a tenth of a magnitude .

As the galactic plane passes through it , Serpens Cauda contains many massive OB stars . Several of these are visible to the naked eye , such as NW Serpentis , an early Be star that has been found to be somewhat variable . The variability is interesting ; according to one study , it could be one of the first discovered hybrids between Beta Cephei variables and slowly pulsating B stars . Although not visible to the naked eye , HD 167971 ( MY Serpentis ) is a Beta Lyrae variable triple system consisting of three very hot O @-@ type stars . A member of the cluster NGC 6604 , the two eclipsing stars are both blue giants , with one being of the very early spectral type O7.5III. The remaining star is either a blue giant or supergiant of a late O or early B spectral type . Also an eclipsing binary , the HD 166734 system consists of two O @-@ type blue supergiants in orbit around each other . Less extreme in terms of mass and temperature is HD 161701 , a spectroscopic binary consisting of a B @-@ type primary and an Ap secondary , although it is the only known spectroscopic binary to consist of a star with excess of mercury and manganese and an Ap star .

South of the Eagle Nebula on the border with Sagittarius is the eclipsing binary W Serpentis , whose primary is a white giant that is interacting with the secondary . The system has been found to contain an accretion disk , and was one of the first discovered Serpentids , which are eclipsing binaries containing exceptionally strong far @-@ ultraviolet spectral lines . It is suspected that such Serpentids are in an earlier evolutionary phase , and will evolve first into double periodic variables and then classical Algol variables . Also near the Eagle Nebula is the eclipsing Wolf ? Rayet binary CV Serpentis , consisting of a Wolf ? Rayet star and a hot O @-@ type subgiant . The system is surrounded by a ring @-@ shaped nebula , likely formed during the Wolf ? Rayet phase of the primary . The eclipses of the system vary erratically , and although there are two theories as to why , neither of them is completely consistent with current understanding of stars .

Serpens Cauda contains a few X @-@ ray binaries . One of these , GX 17 + 2 , is a low @-@ mass X @-@ ray binary consisting of a neutron star and , as in all low @-@ mass X @-@ ray binaries , a low @-@ mass star . The system has been classified as a Sco @-@ like Z source , meaning that its accretion is near the Eddington limit . The system has also been found to approximately every 3 days brighten by around 3 @. @ 5 K @-@ band magnitudes , possibly due to the presence of a synchrotron jet . Another low @-@ mass X @-@ ray binary , Serpens X @-@ 1 , undergoes occasional X @-@ ray bursts . One in particular lasted nearly four hours , possibly explained by the burning of carbon in " a heavy element ocean " .

== = Deep @-@ sky objects == =

== = = Head objects == = =

As the galactic plane does not pass through this part of Serpens, a view to many galaxies beyond it is possible. However, a few structures of the Milky Way Galaxy are present in Serpens Caput, such as Messier 5, a globular cluster positioned approximately  $8^\circ$  southwest of  $\epsilon$  Serpentis, next to the star  $\delta$  Serpentis. Barely visible to the naked eye under good conditions, and is located approximately 25,000 ly distant. Messier 5 contains a large number of known RR Lyrae variable stars, and is receding from us at over 50 km/s. The cluster contains two millisecond pulsars, one of which is in a binary, allowing the proper motion of the cluster to be measured. The binary could help our understanding of neutron degenerate matter; the current median mass, if confirmed, would exclude any "soft" equation of state for such matter. The cluster has been used to test for magnetic dipole moments in neutrinos, which could shed light on some hypothetical particles such as the axion. Another globular cluster is Palomar 5, found just south of Messier 5. Many stars are leaving this globular cluster due to the Milky Way's gravity, forming a tidal tail over 30,000 light years long.

A remarkable dark nebula complex is the L134 / L183 complex. Along with a third cloud, they are likely fragments of a single original cloud located 36 degrees away from the galactic plane, a large distance for dark nebulae. The entire complex is thought to be around 140 parsecs distant. L183, also referred to as L134N, is particularly interesting; there are several infrared sources within, indicating pre-stellar sources thought to present the first known observation of the contraction phase between cloud cores and prestellar cores. The core is split into three regions, with a combined mass of around 25 solar masses.

Outside of the Milky Way, there are no bright deep sky objects for amateur astronomers in Serpens Caput, with nothing else above 10th magnitude. The brightest is NGC 5962, a spiral galaxy positioned around 28 megaparsecs distant with an apparent magnitude of 11.34. Slightly fainter is NGC 5921, a barred spiral galaxy with a LINER type active galactic nucleus situated somewhat closer at a distance of 21 megaparsecs. A type II supernova was observed in this galaxy in 2001 and was designated SN 2001X. Fainter still are the spirals NGC 5964 and NGC 6118, with the latter being host to the supernova SN 2004dk.

Hoag's Object, located 600 million light years from Earth, is one of the most famous of a very rare class of galaxies known as ring galaxies. The outer ring is largely composed of young blue stars while the core is made up of older yellow stars. The predominant theory regarding its formation is that the progenitor galaxy was a barred spiral galaxy whose arms had velocities too great to keep the galaxy's coherence and therefore detached. Arp 220 is another unusual galaxy in Serpens. The prototypical ultraluminous infrared galaxy, Arp 220 is somewhat closer than Hoag's Object at 250 million light years from Earth. It consists of two large spiral galaxies in the process of colliding with their nuclei orbiting at a distance of 1,200 light years, causing extensive star formation throughout both components. It possesses a large cluster of more than a billion stars, partially covered by thick dust clouds near one of the galaxies' core. Another interacting galaxy pair, albeit in an earlier stage, consists of the galaxies NGC 5953 and NGC 5954. In this case, both are active galaxies, with the former a Seyfert 2 galaxy and the latter a LINER type galaxy. Both are undergoing a burst of star formation triggered by the interaction.

Seyfert's Sextet is a group of six galaxies, four of which are interacting gravitationally and two of which simply appear to be a part of the group despite their greater distance. The gravitationally bound cluster lies at a distance of 190 million light years from Earth and is approximately 100,000 light years across, making Seyfert's Sextet one of the densest galaxy group known. Astronomers predict that the four interacting galaxies will eventually merge to form a large elliptical galaxy. The radio source 3C 326 was originally thought to emanate from a giant elliptical galaxy. However, in 1990, it was shown that the source is instead a brighter, smaller galaxy a few arcseconds north. This object, designated 3C 326 N, has enough gas for star formation, but is being inhibited due to the energy from the radio galaxy nucleus.

A much larger galaxy cluster is the redshift 0.0354 Abell 2063. The cluster is thought to be interacting with the nearby galaxy group MKW 3s, based on radial velocity measurements of galaxies and the positioning of the cD galaxy at the center of Abell 2063. The active galaxy at the center of MKW 3s, NGC 5920, appears to be creating a bubble of hot gas from its radio activity.

Near the 5th magnitude star Pi Serpentis lies AWM 4 , a cluster containing an excess of metals in the intracluster medium . The central galaxy , NGC 6051 , is a radio galaxy that is probably responsible for this enrichment . Similar to AWM 4 , the cluster Abell 2052 has central cD radio galaxy , 3C 317 . This radio galaxy is believed to have restarted after a period of inactivity less than 200 years ago . The galaxy has over 40 000 known globular clusters , the highest known total of any galaxy as of 2002 .

Consisting of two quasars with a separation of less than 5 arcseconds , the quasar pair 4C 11.050 is one of the visually closest pairs of quasars in the sky . The two have markedly different redshifts , however , and are thus unrelated . The foreground member of the pair ( 4C 11.050 A ) does not have enough mass to refract light from the background component ( 4C 11.050 B ) enough to produce a lensed image , although it does have a true companion of its own . An even stranger galaxy pair is 3C 321 . Unlike the previous pair , the two galaxies making up 3C 321 are interacting with each other and are in the process of merging . Both members appear to be active galaxies ; the primary radio galaxy may be responsible for the activity in the secondary by means of the former 's jet driving material onto the latter 's supermassive black hole .