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Constellations

Throughout the centuries, people have looked to the stars to help them navigate across open oceans or featureless deserts, know when to plant and harvest, and preserve their myths and folklore. Ancient peoples used the appearance or disappearance of certain stars over the course of each year to mark the changing seasons. To make it easier to "read" this celestial calendar, they grouped the brighter stars into readily recognizable shapes, the constellations.

How many constellations are there?

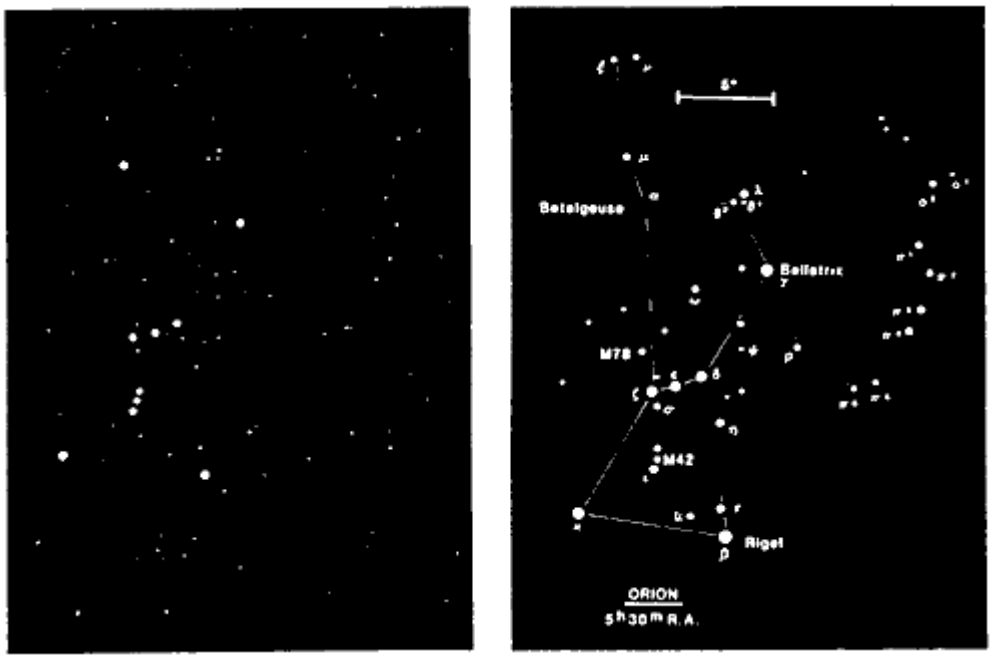
Astronomers officially recognize 88 constellations covering the entire sky in the northern and southern hemispheres. Currently, 14 men and women, 9 birds, two insects, 19 land animals, 10 water creatures, two centaurs, one head of hair, a serpent, a dragon, a flying horse, a river and 29 inanimate objects are represented in the night sky (the total comes to more than 88 because some constellations include more than one creature.) It is important to realize that the great majority of star patterns bear little, if any, resemblance to the figures they are supposed to represent and whose name they bear. The ancient constellation-makers probably meant for them to be symbolic, not literal, representations of their favorite animals or fabled heroes, a kind of celestial "Hall of Fame."

Who invented them?

Our modern constellation system comes to us from the ancient Greeks. The oldest description of the constellations as we know them comes from a poem, called *Phaenomena*, written about 270 B.C. by the Greek poet Aratus. However, it is clear from the poem that the constellations mentioned

originated long before Aratus' time. No one is sure exactly where, when, or by whom they were invented. And yet a little detective work reveals a plausible origin.

The first clue is that Aratus' constellations did not include any near the south celestial pole (the point on the celestial sphere directly above the Earth's south pole) because that area of the sky was always below the horizon of the ancient constellation-makers. From the size of this uncharted area of the sky, we can determine that the people responsible for the original constellations lived near a latitude of 36° north — south of Greece, north of Egypt, but similar to the latitude of the ancient Babylonians and Sumerians.



The constellation Orion as it appears in the sky (left) and with the line drawings of the constellation figure added (right). (From *Star Maps*, [AS 289] a constellation slide set, available from the ASP.

In addition, the constellation-free zone is not centered exactly on the south celestial pole. Because of a "wobble" of the Earth's axis of rotation, the position of the celestial poles changes slowly with time, a phenomenon known as precession. The uncharted area is centered on the place in the sky where the south celestial pole would have been around the year 2000 B.C. This date matches the time of the Babylonians and Sumerians.

Thus it seems likely the Greek constellations originated with the Sumerians and Babylonians. From there, knowledge of the constellations somehow made its way to Egypt (perhaps through the Minoans on Crete who had contact with the Babylonians and settled in Egypt after an explosive volcanic eruption destroyed their civilization), where early Greek scholars first heard about the constellations and wrote about them.

In 150 A.D., the Greek scientist Ptolemy published a book, known by its Arabic name, *The Almagest*, which contained a summary of Greek astronomical knowledge, including a catalog of 1022 stars, with estimates of their brightness, arranged into 48 constellations. These 48 formed the basis for our modern constellation system.

Over the years, astronomers have added constellations to fill in the gaps between Ptolemy's figures and map the uncharted regions of the sky near the south celestial pole. Major contributors of new constellations included Dutch cartographer Gerardus Mercator in 1551 and Pieter Keyser and Frederick de Hautmann, navigators aboard some of the first trading expeditions to the East Indies in the early 1600s, who mapped the southern sky. Polish astronomer Johannes Hevelius in 1690 and French astronomer Nicolas Louis de Lacaille in the 1750s filled in the remaining gaps in the northern and southern skies.

Are there obsolete constellations?

Over the centuries, some astronomers have attempted to name constellations after themselves or to flatter a patron or king. This reached a peak during the heyday of celestial mapping in the seventeenth and eighteenth centuries. Few of these survived longer than the astronomers who named them, although they sometimes can be seen in antique star charts. For example, in 1678, Edmond Halley (of Halley's Comet fame) invented a constellation called Robur Carolinum, or Charles' Oak, in honor of King Charles II of England. This constellation did not last long, especially after its rejection by the French astronomer Lacaille in his maps of the southern sky. In 1754, the English naturalist and noted satirist John Hall invented thirteen constellations

based on rather unappealing animals such as a toad, a leech, a spider, an earthworm, and a slug. Fortunately, even though they may have been intended as a joke, they never caught on.

At its first meeting in 1922, the International Astronomical Union (IAU), astronomy's governing body which is responsible, among other things, for assigning names to celestial objects and features on those objects, officially adopted the list of 88 constellations that we use today. Definitive boundaries between constellations, which extend out beyond the star figures, were set in 1930, so that every star, nebula, or galaxy, no matter how faint, now lies within the limits of one constellation. For today's astronomer, constellations refer not so much to the patterns of stars, but to precisely defined areas of the sky.

Where do individual star names come from?

The ancient Greek tradition was to name stars by their position within a constellation. For example, Ptolemy refers to one star by the description "the reddish one on the southern eye," a star we now know as Aldebaran in the constellation of Taurus the Bull. But these descriptions could get quite involved. Ptolemy refers to another star in the obsolete constellation of Argo the Boat as "the northernmost of two stars close together over the little shield in the poop," a bit cumbersome if you are trying to learn the names of many stars.

When Al-Sufi, one of the greatest Arabic astronomers, published his own version of Ptolemy's *Almagest* in the tenth century, he introduced many individual star names. For centuries, bedouin Arabs had given names to bright stars — for example Aldebaran and Betelgeuse — since they regarded single stars as representing people and animals. Many of the original meanings of the names had been forgotten even in Al-Sufi's time, but some were direct translations of Ptolemy's descriptions. For example, the star name Fomalhaut (in the constellation of Pisces) comes from the Arabic for "mouth of the southern fish," which is how Ptolemy described it in the *Almagest*.

After the tenth century, the works of Ptolemy and others were re-introduced into Europe by the Islamic Arabs, and the Greek books were translated from Arabic into Latin, the scientific language of the day. Thus we know Ptolemy's work from its Arabic translation, *The Almagest*, not by its original Greek title. And it explains why we have a system of Greek constellations with Latin names containing stars with Arabic names.

Did other cultures also see constellations in the sky?

Nearly every culture on Earth has seen patterns in the stars. But, not surprisingly, very few have seen the same patterns. Take, for example, the Big Dipper, perhaps the most recognizable star pattern in the sky. The Big Dipper is not actually a constellation itself, but is part of a larger pattern known to the Greeks as Ursa Major, the Great Bear. The seven stars of the Big Dipper have inspired many stories, perhaps because they are bright and located so near the north celestial pole, around which the stars rotate during the course of the night. But not everyone calls it a Dipper. The British call it a Plough. In Southern France, it is a Saucepan. The Skidi Pawnee Indians saw a stretcher on which a sick man was carried. To the ancient Maya, it was a mythological parrot named Seven Macaw. Hindu sky lore called it the Seven Rishis, or Wise Men. To the early Egyptians, it was the thigh and leg of a bull. The ancient Chinese thought of it as a special chariot for the Emperor of the Heaven or some other celestial bureaucrat. For the Micmac Indians of Canada's Maritime Provinces, along with several other North American Indian tribes, the bowl of the Big Dipper was a bear, and the stars in the handle represented hunters tracking the bear. And in the nineteenth century, the Big Dipper became a symbol of freedom for runaway slaves, who "followed the Drinking Gourd" to the northern states.

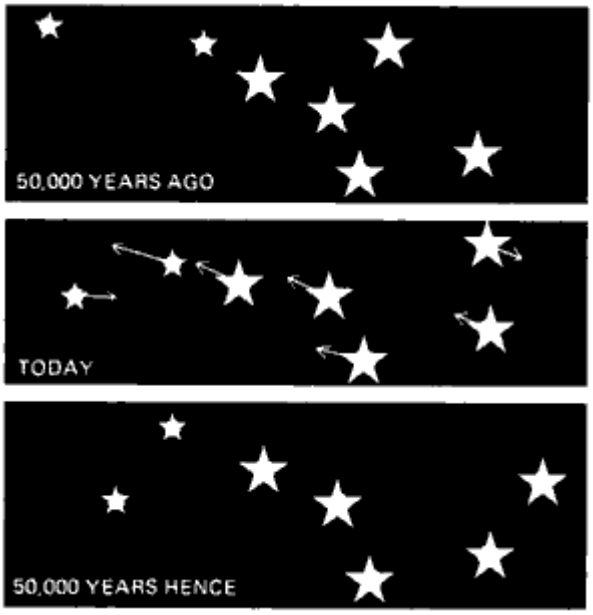
Are all the stars in a constellation the same distance away from us?

No. With few exceptions, the stars in a constellation have no connection with one another. They are actually at very different distances from the sun (see Activity Corner). Chance alignments of stars have created the patterns we see in the sky.

Are the constellations permanent?

Ancient astronomers often spoke of the "fixed stars," which maintained permanent positions in the sky. And, indeed, the stars do seem almost fixed in place; the patterns they form look much the same today as they did when the constellations were first named nearly 3000 years ago. But the stars are all moving relative to the Sun, most with speeds of many kilometers per second. Because they are so very far away, it will take

thousands of lifetimes to see significant changes in the star patterns. But, over time, they will change. Because of the motions of the stars within it, for example, the handle of the Big Dipper will, in about 50,000 years, appear significantly more bent than it is today (see figure at right). We will, no doubt, keep the same names for the constellations, even if the stars change their positions. Constellations are, after all, products of human imagination, not nature.



Constellations

TABLE: The Constellations

The Latin names and meanings of the official 88 constellations are given below. The original 48 constellations of Ptolemy are indicated with an asterisk*. Ptolemy's constellation Argo the Boat was later divided into three parts (Carina, Puppis, and Vela, which are noted).

Latin Name	Meaning	Latin Name	Meaning	Latin Name	Meaning
Andromeda*	Daughter of Cassiopeia	Cygnus*	The Swan	Pavo	The Peacock
Antlia	The Air Pump	Delphinus*	The Dolphin	Pegasus*	The Winged Horse
Apus	Bird of Paradise	Dorado	The Swordfish	Perseus*	Rescuer of Andromeda
Aquarius*	The Water-Bearer	Draco*	The Dragon	Phoenix	The Phoenix
Aquila*	The Eagle	Equuleus*	The Little Horse	Pictor	The Painter
Ara*	The Altar	Eridanus*	The River	Pisces*	The Fishes
Aries*	The Ram	Fornax	The Furnace	Piscis Austrinus*	The Southern Fish
Auriga*	The Charioteer	Gemini*	The Twins	Puppis*	The Stern (of Argo)
Boötes*	The Herdsman	Grus	The Crane (bird)	Pyxis	The Compass
Caelum	The Chisel	Hercules*	The Son of Zeus	Reticulum	The Reticle
Camelopardalis	The Giraffe	Horologium	The Clock	Sagitta*	The Arrow
Cancer*	The Crab	Hydra*	The Water Snake (female)	Sagittarius*	The Archer
Canes Venatici	The Hunting Dogs	Hydrus	The Water Snake (male)	Scorpius*	The Scorpion
Canis Major*	The Big Dog	Indus	The Indian (American)	Sculptor	The Sculptor
Canis Minor*	The Little Dog	Lacerta	The Lizard	Scutum	The Shield

Capricornus*	The Goat	Leo*	The Lion	Serpens*	The Serpent
Carina*	The Keel (of Argo)	Leo Minor	The Little Lion	Sextans	The Sextant
Cassiopeia*	The Queen	Lepus*	The Hare	Taurus*	The Bull
Centaurus*	The Centaur	Libra*	The Balance	Telescopium	The Telescope
Cepheus*	The King	Lupus	The Wolf	Triangulum*	The Triangle
Cetus*	The Whale	Lynx*	The Lynx	Triangulum Australe	The Southern Triangle
Chamaeleon	The Chameleon	Lyra*	The Lyre	Tucana	The Toucan
Circinus	The Compasses	Mensa	The Table	Ursa Major*	The Great Bear
Columba	The Dove	Microscopium	The Microscope	Ursa Minor*	The Little Bear
Coma Berenices	Berenice's Hair	Monoceros	The Unicorn	Vela*	The Sails (of Argo)
Corona Australis*	The Southern Crown	Musca	The Fly	Virgo*	The Maiden
Corona Borealis*	The Northern Crown	Norma	The Square	Volans	The Flying Fish
Corvus*	The Crow	Octans	The Octant	Vulpecula	The Fox
Crater*	The Cup	Ophiuchus*	The Serpent-Bearer		
Crux	The Cross	Orion*	The Hunter		

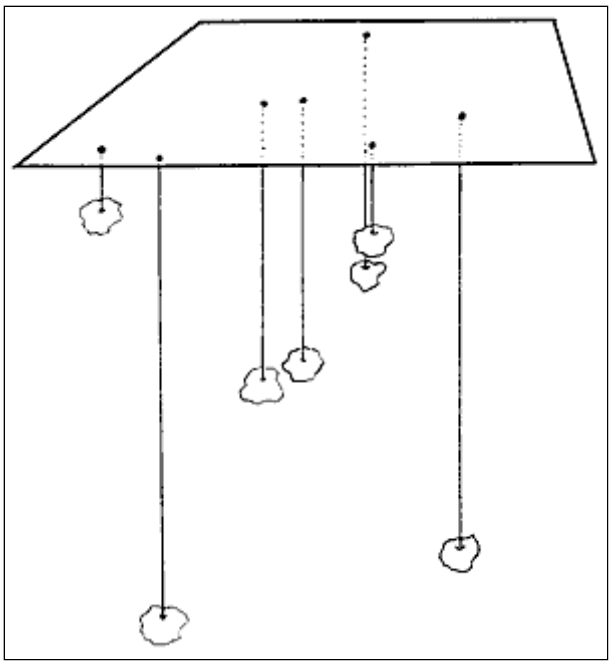
Activity Corner: Three-Dimensional Orion

by Sally Stephens, ASP Education Coordinator

Orion, the Hunter, is one of the few constellations that looks like what it is supposed to be (see picture). It is not hard to envision a hunter holding a shield and a sword, defending himself against a charging Taurus the Bull. But the stars that make up Orion lie at very different distances from the Sun. Their resemblance to a human figure is a chance alignment. Viewed from another angle, they would not look anything like a hunter. To illustrate this, we can make a three-dimensional model of Orion's stars in space.

Materials:

Large sturdy piece of cardboard (15" by 12")
Ruler
7 cotton balls
String
Glue or tape
Pin or scissors (to make holes)



Instructions:

Tie string around each cotton ball (which represents a star), leaving at least 20 inches of string trailing off from the cotton ball. Place cardboard so that the long side is facing you. That side will be called the "front". For each star, measure as far along the front edge from the right hand corner as indicated by the number in the column marked "Measurement from Right". Then, measure back along a line perpendicular to that edge, a distance equal to that in the column marked "Measurement from Front", and make a hole in the cardboard with a pin or the tip of a scissors at that point. Thread one string through the hole so that the cotton ball hangs down under the cardboard the same distance as in the column marked "Length of String". Tape or glue the string to the top of the cardboard so that the "star" will not move. When all the stars have been put in their place in space, hold the cardboard up so that the "front" is again facing you. You will see the stars of Orion in their familiar pattern. Turning the cardboard will show the positions of the stars in space relative to one another. Also, note that the stars only look like a hunter when viewed from certain perspectives.

Name of Star	Measurement from Right	Measurement from Front	Length of String
Betelgeuse	13 3/4"	1 7/16"	1 15/16"
Rigel	3 3/4"	4 7/16"	13 5/8"
Bellatrix	6 1/4"	1 5/8"	2 3/4"
Mintaka	8"	10 13/16"	7 3/4"
Alnilam	9"	5 9/16"	8 3/8"
Alnitak	10 1/4"	5 1/8"	8 15/16"
Saiph	12"	5/16"	14 3/4"

Other Constellation Activities

Given a star chart without constellation figures marked on it (whether real star charts or made-up star patterns), students can invent their own constellations, looking for patterns in the stars that appeal to them. Students can then be asked to make up stories to go with their new constellations.

Older students can research the constellation patterns and stories that other cultures saw in the night sky and compare them to the more familiar Greek ones. This can be done by reading books and articles, or by interviewing family members or friends.

Maps of the stars in the constellations can be useful in the classroom. Slide sets, such as Star Maps (a sample of which is on the previous page) which show actual pictures of each constellation in the night sky and separate line drawings of the constellation figures, can help students identify the constellations as part of homework assignments or evening "star parties." This can be especially helpful for students without easy access to a planetarium.

For Further information about Constellations:

- Allen, R. *Star Names: Their Lore and Meaning*. 1899, 1965, Dover Books reprint.
- Krupp, E. *Beyond the Blue Horizon: Myths and Legends of the Sun, Moon, Stars and Planets*. 1991, Harper Collins.
- Proctor, P. *Star Myths and Stories*. 1972, Exposition Press.
- Ridpath, I. *Star Tales*. 1988, Universe Books.

Especially for Younger Children:

- Rey, H. A. *Find the Constellations*. 1976, Houghton-Mifflin. A classic guide with simplified diagrams and text.
- Schatz, D. *Astronomy Activity Book*. 1991, Simon and Schuster. Wonderful book of astronomy activities for the whole family or elementary and middle schools.