

THE CONSTELLATIONS

Jan Wrightson
Bridgwater Astronomical Society

How often do you think about the constellations? Really think about them, as in where did they come from? As in why do we group the stars as we do and why do we refer to them as animals and birds and figures from Greek mythology?

If you went outside on a clear night in mid March and looked up at the sky, probably the first thing you would do would be to look round and pick out the pattern of stars we call the Plough to get your bearings. You'd find it standing on its end. Then you might follow the line of the two stars we know as the Pointers to the left to find Polaris in Ursa Minor.



Then you might turn round and look south to find Gemini, with Leo to the south east.

A bit further round to the south west you'd find Orion and Taurus.

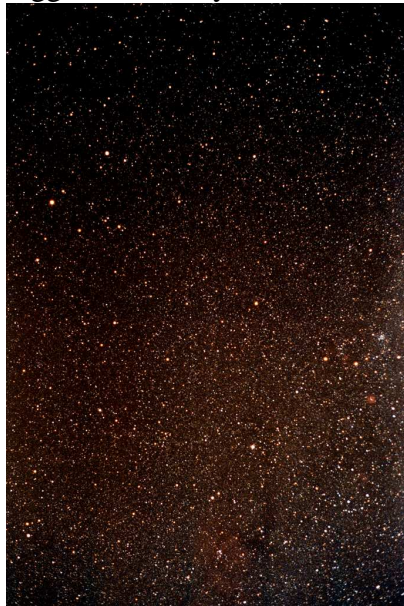


The fact that you'll see Orion and Taurus in the south west and sinking towards the horizon tells us that we're getting towards spring, as these are winter constellations. We'd also realise it was getting towards spring if we look the other way, and saw Virgo starting to creep over the eastern horizon, since Virgo is a summer constellation.

In the 21st century we don't need to use the sky to tell us what time of year it is. We only have to turn on the television, or look on our computer screens, to find both date and time, but it hasn't always been so.

But first let's think about what we mean by a constellation.

A constellation is simply a group of stars. They may be related to each other, moving together, but the chances are they're not. Another word for exactly the same thing is an asterism. We normally use the word asterism to describe a small group of stars making up a part of a constellation, but this isn't always a good distinction. The Plough is actually an asterism, and is also part of the constellation Ursa Major, the Great Bear. The Plough is bigger than many constellations.



So what purpose does a constellation, or indeed an asterism, serve? It's simply a way of remembering a certain pattern of stars, so that every time we see the brighter members in that pattern, we recognise the whole constellation. It's a lot easier than trying to recognise every bright star in the sky as an individual. Recognising patterns and using them to aid memory is something the human brain does well.

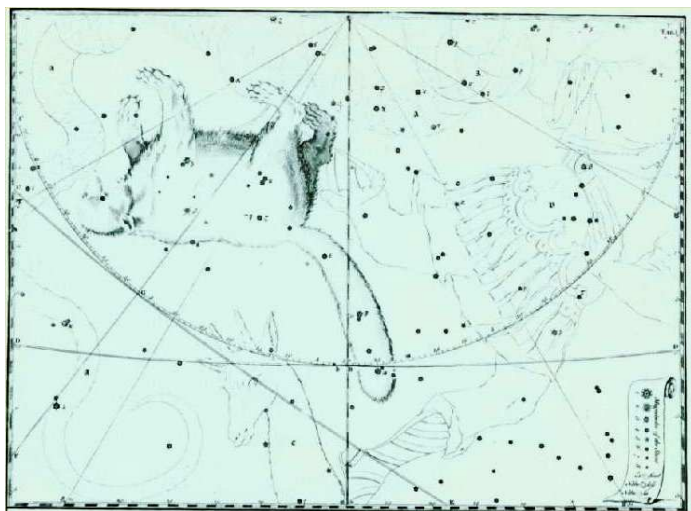
Of course we do recognise stars, but usually we think along the lines of: That's Gemini so those two bright stars there are Castor and Pollux, or: there's the Plough so if I follow the curve of the handle round.... yes, that's Arcturus. Usually we look for constellations first, then stars.

Because the stars in a constellation may be completely unrelated to each other, we only see the pattern we see because of the relative positions of the Earth and the stars.

Let's leave the Plough for a moment and look at a neighbouring constellation that's nearly as well known, Ursa Minor or the Little Bear. Polaris, the Pole Star and Alpha Ursa Minor, lies about 400 light years away. Beta Ursa Minor, or Kochab, lies only about 120 light years away. If we were on a planet somewhere else in our galaxy, our little bear would look very different. Because of that, and because stars which are unrelated are moving through space at different speeds, constellations and asterisms such as our friend the Plough change shape over thousands of years. Not only that, but the wobble of the Earth means that Polaris has not always been the star at the north celestial pole, nor will it always be so.

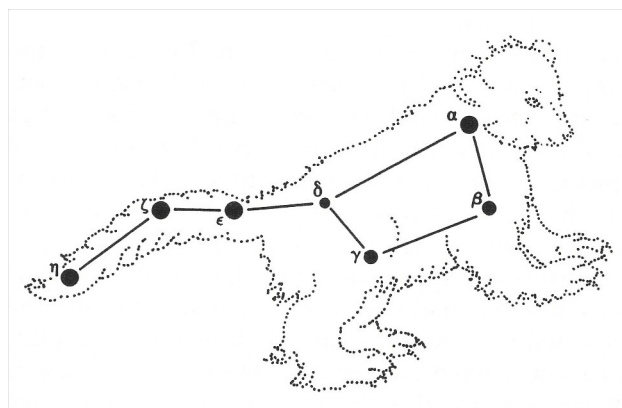
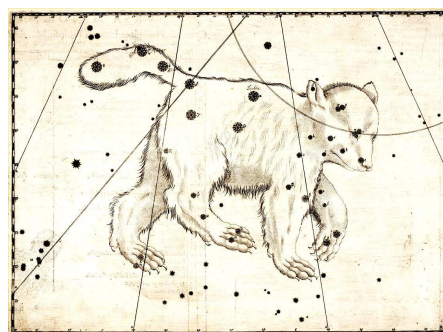


The movement of stars in the Plough can be fairly easily shown since most of the stars actually are associated with each other. Only two are not. You've probably all seen diagrams or animations of how the shape of the Plough has changed over thousands of years.



So, why the Great and Little Bears? Once the ancient farmers of thousands of years ago had worked out that at a certain time of year a certain group of stars appeared in the sky, they had to give that group of stars a name so they'd know it again. Logically, early civilisations would have given their constellations the names of birds and animals, and probably some of the implements they used in their daily lives - anything that the pattern of stars made them think of.

Every culture the world over has its own constellations and names for them. Many of the actual star patterns are similar if not the same, but you could expect that. Look at just the bright stars in the sky and a lot of them tend to fall into natural groups. What is less easy to explain is that some constellations are seen as the same creature across different cultures. For example our friend the Great Bear - Ursa Major.



We know the bear from Greek mythology - the immortal embodiment of Callisto, a woman sworn to virginity who bore a son by Zeus or Jupiter, the king of the gods. Arcas, her son, is the Little Bear. This is probably a good time to briefly look at mythology as we know it. Although we know a lot of stories from Greek mythology, its origins almost certainly predate the Greeks. Then when the Romans came along, they borrowed it for themselves. They had the same gods, but

gave them different names, so Zeus and Jupiter are one and the same. Zeus is his Greek name, Jupiter his Roman one.

Originally the Great Bear only used the stars we call the Plough. But many American Indian tribes also saw a bear, and their bear was formed by the plough blade alone. The Babylonians, from what is now Iraq, saw a wagon. The Teutonic people of early Germany also saw a wagon, but theirs was pulled by a team of horses.

The earliest record of an attempt to catalogue stars and constellations is thought to be in some cuneiform clay tablets found in the valley of the Euphrates River in what is now southern Iraq. These refer to a lion, a bull and a scorpion - Leo, Taurus and Scorpio. They also refer to the Sun being in the bull, or Taurus, at the start of the year, which then would have been the Vernal or spring equinox. This dates them to around 2450BC.

The pictograms on these tablets were the work of the Sumerian people. They were conquered

in the 23rd century BC by the Akkadians, then about four hundred years later the centre of power shifted from the Sumerian city of Ur to Babylon, which continued as the seat of learning and culture in spite of being conquered several times. Finally Alexander the Great took the city from its previous owners, the Persians, in 331BC, and it became part of the Greek empire. After spending some time under Iranian rule, in 64AD the region became Roman. This was after the Romans had conquered Greece in 30BC. Hence we have a link through from the early Sumerians, through Babylon and Greece to Rome, and ultimately to western Europe.

The origins of the zodiac and the zodiacal constellations as we know them today are attributed to the Babylonians. The Babylonians developed a very sophisticated 60 base numerical system which originated from the earlier Sumerians and remains to this day in our circle of 360 degrees, hour of 60 minutes and so on. This enabled them to define the ecliptic - the path the Sun, Moon and planets take across the sky. This was about 1000 to 1500 years



BC.

The constellations along the ecliptic form what we call the zodiac. Shown here on an Egyptian planisphere, the zodiacal constellations are given prominence around the outside, although they are not all in a form we would recognise now. The zodiacal constellations evolved as a simple means of keeping track of the Moon and planets and providing them with a reference point. As the calendar settled on twelve months in the year, so there are twelve constellations along the ecliptic, or zodiac.

Observing the Moon, Sun and the constellations they moved through enabled the Babylonians to correct their early lunar calendar - governed by the Moon's phases - to the solar year. This type of calendar is called lunisolar. Now if you think about it, observing the phases of the Moon and using it to define a month is pretty straightforward. There is evidence to suggest that the Cro-Magnon people, who were an early European race, were using a lunar calendar

some 32000 years BC. But if your calendar is purely lunar, the months are not at the same time of year from one year to the next, and so are no use for determining, for example, when to plant and harvest crops. To make it truly useful you need a correction for the solar year, but determining the position of the Sun relative to the stars is a lot harder than for the Moon, because of course when it's daylight you can't see the stars. A true lunisolar calendar takes account of the fact that there are more than 12 lunar months in a solar year and makes adjustments accordingly. The Babylonian calendar almost certainly derived from an earlier Sumerian. Originally there were 18 zodiacal constellations, but by the 5th century BC this had become 12, in line with the calendar.

Around 3000BC the Egyptians had an administrative calendar of 12 months of 30 days each and five extra days. It was they who developed the leap year, adding a day to their administrative calendar every four years to keep it in line with the religious agricultural one. They used marker stars or groups of stars called decans to track time at night. Approximately twelve decans rose during the night, and very possibly this is where the notion of nominal twelve hour nights and days came from.



We associate much of our knowledge of the constellations with Greek mythology, which has the gods at the heart of it. There is a reason for this, and it predates the Greeks and almost certainly the Babylonians as well. Imagine you are living in a world you really don't understand. You don't know why the Sun shines, you don't know what the Moon is or what the stars are. You don't know why there are floods that wash your crops away or droughts that bake them. You certainly don't know anything about eclipses. You need some

explanation for all this, and the simplest sort of explanation is that some being or beings control and govern what happens. Given that you can't see these controlling beings - you don't know where they are - you've just created gods. You also need an explanation of creation, the reason why the Earth and all its creatures, including humans, came to be in the first place. Most cultures now only have one god, and it's fairly well accepted that a god is a merely a concept. It's not a real being that can truly influence anything, nor did it really create the Earth and everything in it, although of course to some people it can and it did. We know God is not real because we have scientific explanations. We know a lot about the mechanisms that make our earth behave the way it does and about the solar system it's part of. We know slightly less about the universe that surrounds us, but still quite a lot. Ancient civilisations only had their gods. There were lots of them, all with their own areas of influence, and these gods encompassed the sky as well as the earth. In many ancient cultures there is this notion that what we would now call heaven and earth were inextricably linked - that events in one influenced, and were influenced by, events in the other.

The Sumerians had An, the god of the heavens, En-Lil, the god of sky and wind, and En-Ki, the god of the waters, as well as a host of lesser gods. The Babylonians worshipped Marduk,

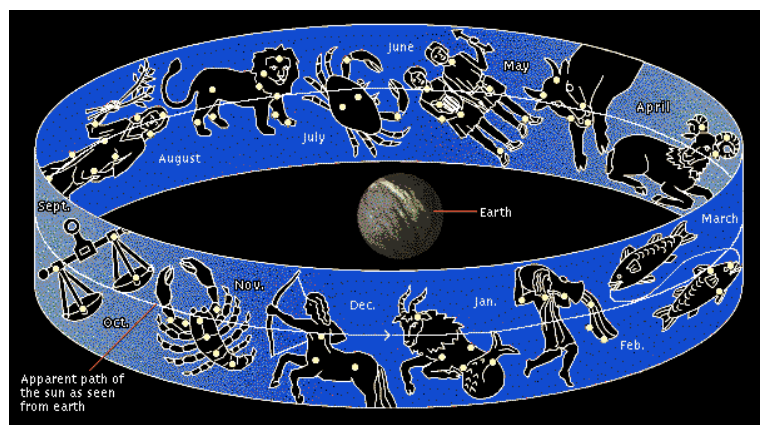
the sun god, who ruled over the earth, and also had Anu, the god of the heavens, Enlil the god of sky and wind and Ea who ruled the subterranean waters. The later Greek gods seem to have been quite fun loving, but those of earlier civilisations were commonly thought to have a grudge against humans, who were constantly looking for ways to appease their gods, to understand them, and to work out what was in store for the people next. Many cultures and religions have a Great Flood story. To the Sumerians it was just one more attempt by their gods to destroy them,

So the sky came in for intense study, and not just because it was the calendar, telling people the right time to plant their crop. The Babylonian numbering system enabled them to perform calculations and record observations of the motions of the known planets and the Moon, the periodic appearances of comets and the timing of eclipses.

We know more about the Greek gods than Sumerian and Babylonian. Top of the heap was Zeus, or Jupiter to give him his Roman name, and he is reputed to have put a lot of people - some great heroes and some very ordinary, into the sky, along with the animals which were largely already there. The planets were named for gods in Mesopotamia by 800BC and possibly earlier.

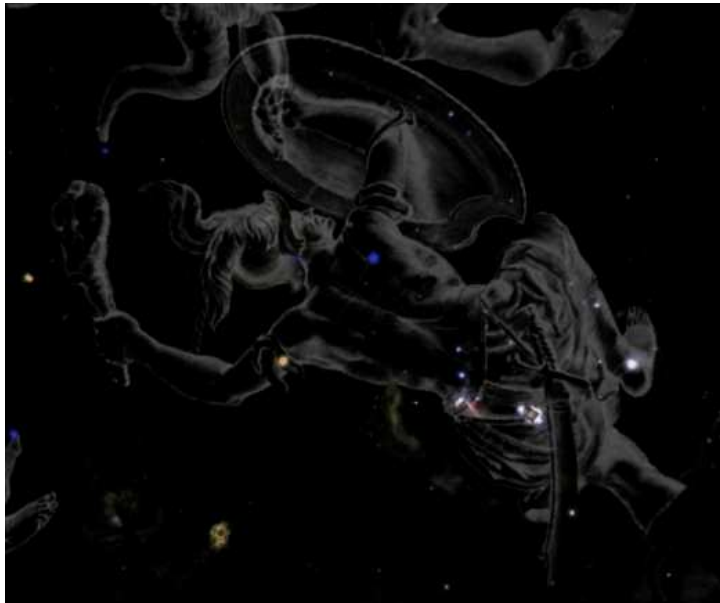
Note that in the image at the head of this section, Hercules is wrestling Cerberus. In the later age of star maps many people gave rein to their imaginations. It's what would ultimately lead to the constellations we have now.

A very ancient notion has it that the gods were on this earth long before mere mortals. They created mortals as slaves, so they themselves didn't have to work, but they lived among their slaves. Greek and Roman mythology elevated the gods to the mountain. The Christian idea of one god in some place up there called heaven isn't too far removed from a whole pack of gods messing about on a mountain.



The zodiacal constellations survived from Babylonian astronomy into Greek. We may scoff at astrology, but there is no doubt that before either became as well developed as they are now, astronomy and astrology were one and the same, and one did not exist without the other. Ancient astrology was rather different to what we see now. I've already mentioned the close link between the heavens and the earth, that events in one affected events in the other. Anything unusual happening in the sky could be a portent for those below. This is the basis of astrology, but a slightly different form to the one we know. It was society orientated, rather than individual orientated, in other words what happened in the sky foretold events for the people in general. The idea that an individual's time of birth held meaning and that they alone could be influenced by stars and planets didn't come till during the Persian occupation of

Babylon, and even then it was of no consequence to the ordinary people. It is only comparatively recently that western civilisation has seen a clear division between astronomy and astrology. In some eastern cultures, of course, they still walk hand in hand.



The earliest references to the mythological constellations come from Homer's *Iliad* of about the 7th century BC but possibly earlier. We find the Pleiades, the Hyades, Orion (seen here) and a Bear, which was female. Hesiod, writing at about the same time (it should be noted that it is very difficult to date any works of the time precisely - sometimes difficult to know precisely who did write them) referred in one of his epics, *Works and Days*, to the Pleiades, the Hyades and Orion. The constellation of Ursa Minor was

possibly defined by Thales of Miletus, which is now in Turkey. He is thought of as the first Greek philosopher and mathematician and travelled in Egypt. It is possible that he brought the Babylonian constellations to Greece two hundred years or more before Alexander the Great. It is claimed that he used Ursa Minor in a book on navigation, but anything he did write was lost.

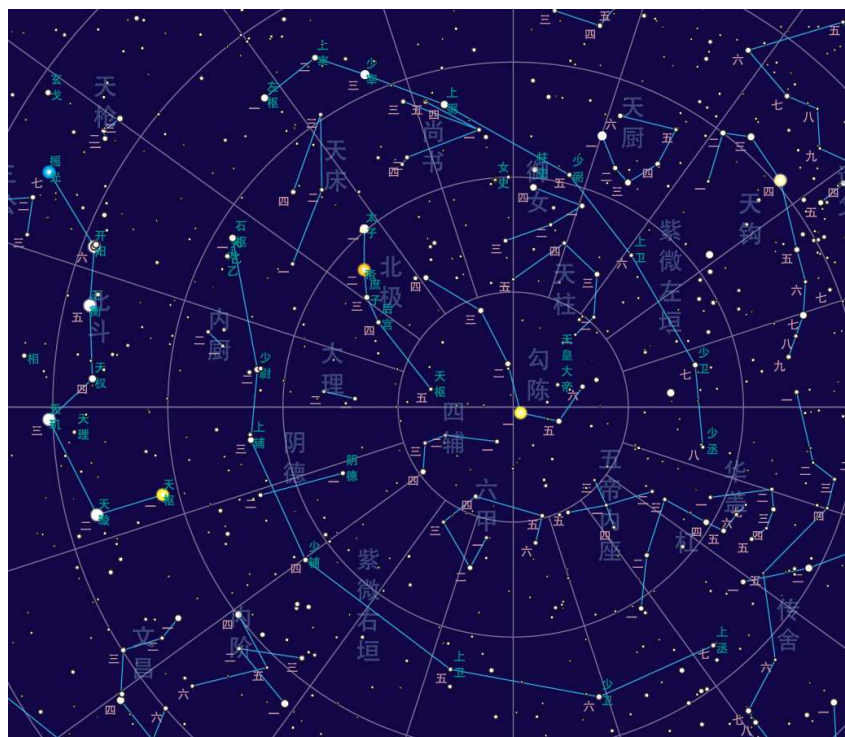
The first writer to refer extensively to the constellations was Eudoxus. This was in around 400 BC. His own works are all lost but they are known through work of others, principally Aratus. He was working in Athens. Part of his poetic work *Phaenomena* ('Appearances'), from about 270 BC, derived from an earlier work by Eudoxus and describes constellations and other celestial phenomena. It identified 47 constellations, which may have had their origins in Egypt. There had long been Greek settlements in Egypt, but during the reign of the Ptolemys (by the way not to be confused with Claudius Ptolemaeus of Alexandria, the mathematician and astronomer, who came later) the Greeks became more influential. Alexandria was one of three Greek city-states in Egypt. Now given that these writers are Greek with some Egyptian influence, you can imagine that there is an empty space in their view of the sky, the part that never becomes visible from Greece or Egypt, a bit they know nothing about. However, this constellation free zone corresponds to an observer at about 36 deg N, ie south of Greece but north of Egypt. Also, the constellation free zone is centred on a south celestial pole before the time of Aratus and Eudoxus. Studies suggest dates between 1130 and 3000 BC. This time and latitude only match the Babylonians (and their Sumerian ancestors), which suggests that the constellation knowledge they handed down was more extensive than just the zodiac, and that the early Greek writers didn't bother to correct it to their own time. Another point of interest about *Phaenomena* is that it seems to refer to Hercules as 'a Phantom form. Like to a man who strives to a task'. What that task is, no-one seems to know, but 'men simply call him On His Knees'.

Catasterismi, a Greek Alexandrian work of prose, possibly attributed to Eratosthenes about 250BC and telling of mythic origins of stars and constellations, makes the following

statement. 'At this stage, the fusion between astronomy and mythology is so complete that no further distinction is made between them.' In other words, the stars did not represent the mythological figures of gods and heroes, they really were those beings. So there were three extremely close links in the ancient world that was to have so much influence over us - heaven and earth, astronomy and astrology and astronomy and mythology. Two of those links are still alive and well. Perhaps it's a pity that it's the third that has been lost. That one seemed the most interesting of them all.

But gods or no gods, mankind's understanding of the world around it was moving on. Around 127 - 147 BC Hipparchus (who was a Greek from what is now Turkey), was able to construct accurate models of the motions of the Sun and Moon using techniques derived from the Babylonians. He was able to use this knowledge to predict solar eclipses. The vernal or spring equinox was defined at the time of Hipparchus. The Sun was then in Aries, hence the 'first point of Aries'.

His star catalogue was adopted by Claudius Ptolemaeus, more often known as Ptolemy, in the second century AD. Ptolemy's *Almagest* grouped 1022 stars into 48 constellations. These were only northern hemisphere constellations, but his work formed the basis for the constellations officially recognised now.



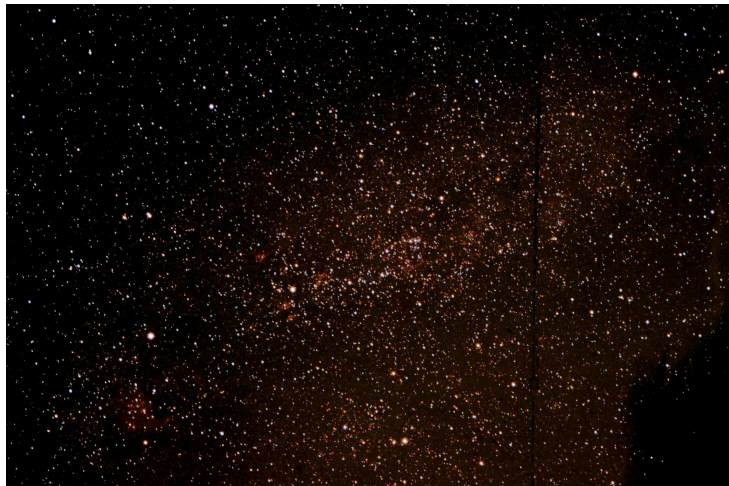
Chinese astronomy developed independently. Their belief was that events on Earth and in the sky mirrored each other absolutely and that anything unusual in the sky was a portent for the area of society represented by the part of the sky in which the comet, eclipse or whatever was seen. The concept of the zodiac is there but it represents the movement of the Moon rather than Sun and is divided into 28 mansions or houses. The circumpolar stars are

represented by 3 enclosures. These mansions and enclosures are subdivided into 283 asterisms rather than the smaller number of larger constellations that we utilise.

The Purple Forbidden Enclosure, shown here, is the area around north celestial pole and represents the walls of the imperial palace and the emperor and his family. It's interesting to note that what we call the Plough is the only recognisable asterism in this area, but it's so obvious that it's not surprising every culture has used it. Western astronomy was introduced to China during the 17th century, and as a result 23 asterisms were added to cover the southern region.

The Hindu system is similar with 27 or 28 Nakshatras or lunar constellations.

Across the globe, different cultures had their own view of the sky. Stories survive from the Chinese, Hindus, from South America and the Antipodes, but it is the Greek view that has gained official recognition. The reason for that must be its acceptance in Europe. In the first millennium BC the major civilisation across what is now a large part of northern Europe was that of the Celtic people. It is known that they had a calendar that was very close to the Hindu, but the Celts in the south east traded with Greece, and later the Roman Empire, which adopted and adapted Greek mythology and astronomy, spread over most of the Celtic lands. Much later, it was Europe which took its turn as the centre of learning and science, just at the time when major discoveries were being made.

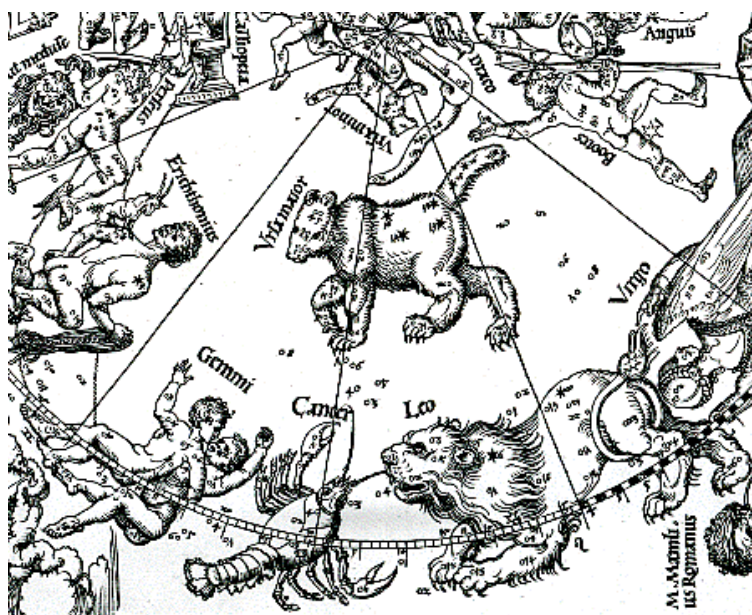


Long before that, though, and not long after Ptolemy's time, the Greek/Roman empire went into decline. Fittingly, since our story started in Mesopotamia, or southern Iraq, the centre of civilisation and learning shifted to Bagdad. Abd Al Rahman Al Sufi published his Book of Fixed Stars in 964AD. As Ptolemy had updated the work of Hipparchos, so this was an update of Ptolemy's Almagest. It introduced Arabic

star names, many based on Ptolemy's descriptive positions. For example Fomalhaut derives from an Arabic translation of the descriptive 'mouth of the southern fish'. Al Sufi also made the earliest recorded observations of the Andromeda Galaxy and the Large Magellanic Cloud. From the 10th century AD many Greek works translated into Arabic were translated again into Latin (the then scientific language) and Ptolemy was reintroduced to Europe. Hence the situation we now have - Greek constellations with Latin names and mainly Arabic star names. So in this illustration we have Cygnus, the swan - a mortal transformed into the great white bird by Jupiter or Jupiter himself transformed, whichever story you like best. To the Greeks it was just a bird. In Roman times it became a swan. Alpha Cygni is Deneb, from the Arabic for tail. Beta - Albireo - is a corruption of the original beak.



It was the 16th century before the first printed star chart that we're all used to today appeared in Europe. This was produced by Albrecht Durer in 1515 and took the form of two woodcuts, for the northern and southern skies, based on Ptolemy's Almagest. Note the prominence given to the zodiac in the northern sky. Note also that not all the constellations names are as we know them now.

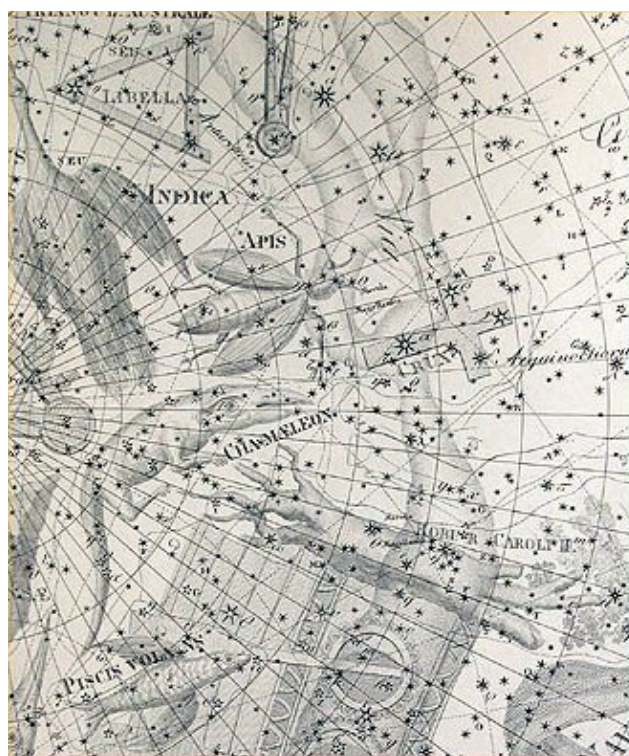


Auriga, the charioteer, is Erichthonius, who invented the chariot to get around, as he was lame. And the serpent or snake in the hands of Ophiuchus is not Serpens. Ophiuchus is the Serpent Bearer, and here he truly is. Note that the view is from the outside in, not the view from the Earth we'd expect to see. This was not unusual for the time.

And the empty part of the southern sky? Obviously the peoples of the southern hemisphere knew this part of the sky.

For example the Southern Cross (Crux) is seen variously as an almond, a knee cap, a ray, a net for catching worms, a fish (these all being the stars of Crux); a fishing spear, an eagle's foot (these two stealing gamma Centaurus); part of a bird snare, the foot of a rhea, and part of a rhea being attacked by dogs (these being larger constellations). If they'd produced a star chart there would have been a corresponding empty space to the north.

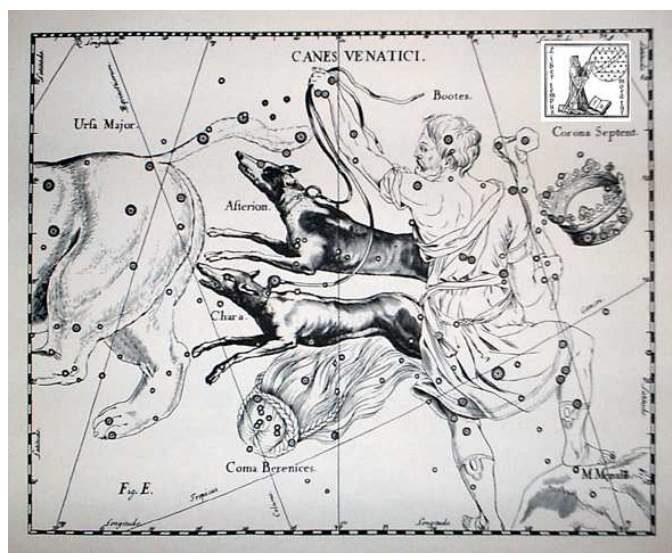
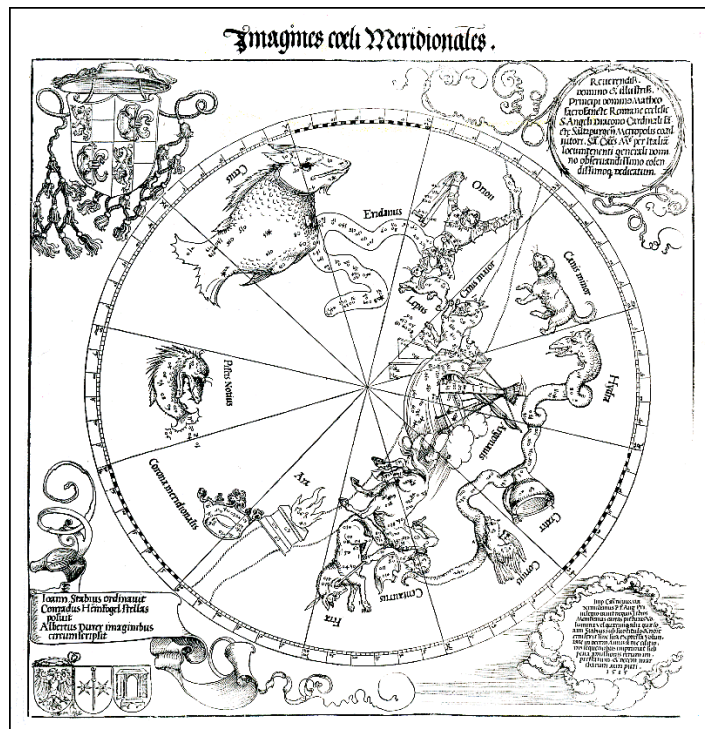
Durer's southern chart, below, shows the now defunct Argo Navis, the ship of Jason and the Argonauts, Cetus the whale, which was originally a sea monster or dragon, and Centaurus. The creature on the end of the spear is what we now call Lupus, the wolf, but was originally merely an undefined creature on the end of a spear.



The star atlases of the sixteenth, seventeenth and early eighteenth centuries were not just star charts, they were beautifully illustrated works of art showing the author's interpretation of how the stars fitted in their constellations. There were no rules - the constellations may have been the same but the figures were often different, and there was nothing to stop anyone inventing new constellations, either out of known stars or newly plotted ones.

The first Europeans to map the southern skies were Petrus Plancius and Pieter Dirkszoon Keyser. Keyser made the observations on the first Dutch voyage to the East Indies at the end of the 16th century, which proved fatal to him and most of the crew, but his data made it back and Plancius 'invented' 12 new constellations from it - Apus, Dorado, Hydrus, Musca, Phoenix, Tucana, Chamaeleon, Grus, Indus, Pavo, Triangulum Australe and Volans. Together with Columba, which he put together from another source, these were published in Johann Bayer's Uranometria in 1603. This was the first atlas to cover the entire celestial sphere. It contained the 48 Ptolemaic

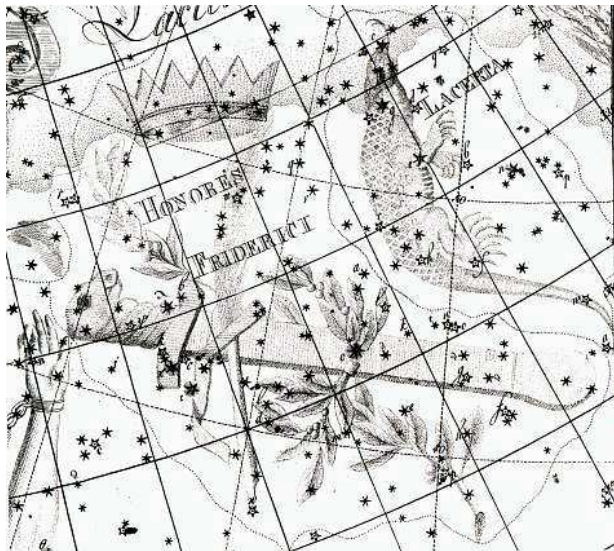
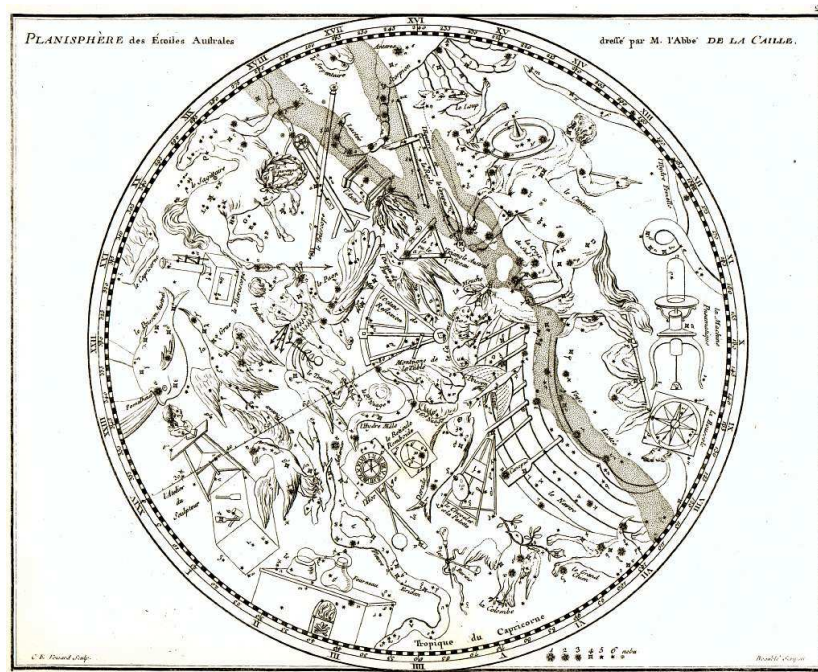
constellations plus the new ones. Positions of the stars were taken from Tycho Brahe's star catalogue. It also introduced the Bayer star designations (Alpha Ursa Majoris, sigma Orionis etc) still used today (but not for Keyser's southern stars - these were designated later by La Caille). With the exception of Ara, the altar, all the constellations shown here can be attributed to Keyser and Plancius. Ten years later Plancius added the northern constellations Monoceros and Camelopardalis to his list.



Johannes Hevelius published his star catalogue in 1687. He introduced Canes Venatici, Lacerta, Leo Minor, Lynx, Scutum, Sextans and Vulpecula - northern constellations made up the less bright stars. Vulpecula, as we'll see later, was not originally as it is now. Here we see Bootes the bear driver shoving Ursa Major around the sky, for the first time being helped by his dogs Canes Venatici.

Many southern constellations are attributed to Abbot Nicholas Louis de la Caille, a French astronomer who went to the Cape of Good Hope to determine the Sun's parallax by observing that of Mars and Venus between 1750 and 1754. He named 14 constellations shown on the planetarium below. These were Antlia, Caelum, Circinus, Fornax, Horologium, Mensa, Microscopium, Norma, Octans, Pictor, Pyxis, Reticulum, Sculptor and Telescopium. You'll note that the constellations of Plancius and Keyser are in the main birds and animals while la Caille's are scientific instruments. Keyser may well have listened to indigenous

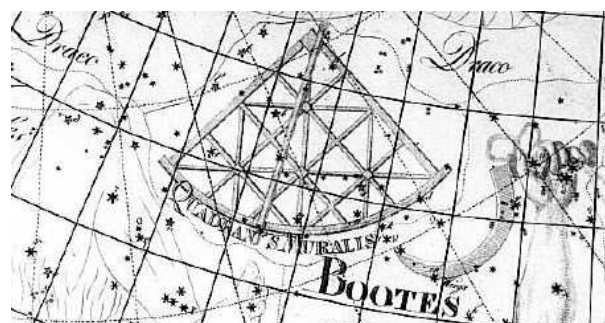
peoples on his travels, or may have named his constellations for creatures that were new to him. By contrast, the 17th and 18th centuries were the time of new scientific discoveries and inventions, for example the telescope and microscope. Galileo is credited with inventing the telescope in the early years of the 17th century.



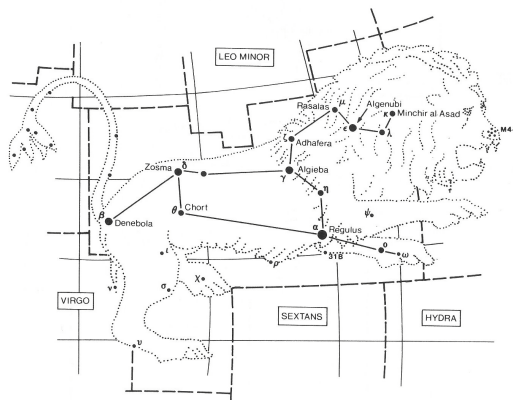
There have been a number of constellations over the ages that we don't recognise now. Some just never caught on, and some were a blatant attempt to gain favour. One such was Honores Friderici, represented here by the sword, introduced by Johann Elert Bode in his *Uranographia* of 1801 in honour of King Frederick of Prussia, who had died the previous year. It was partly to put a stop to this practice that 88 constellations were officially recognised by the International Astronomical Union at its first ever general assembly in 1922. These were formalised in 1930 by publication of 2 books - *Delimitation Scientifique des Constellations* and *Atlas Celeste*.

The finely illustrated star atlases that we've been looking through had been slowly dying out for some time, and the formation of the IAU ushered in the age of stars linked by straight lines into constellations that have been boxed around, so let's finish with a quick look at a little of what we've lost.

The Quadrant - Quadrans or Quandrans Muralis, the wall quadrant, was the invention of Joseph Jerome de Lalande, following La Caille's theme of scientific



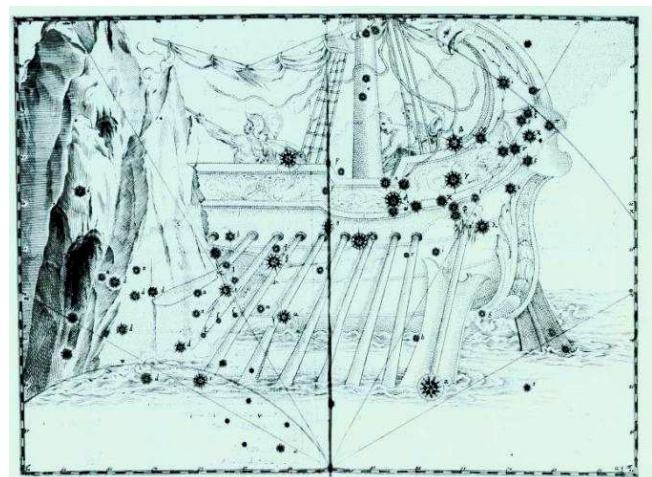
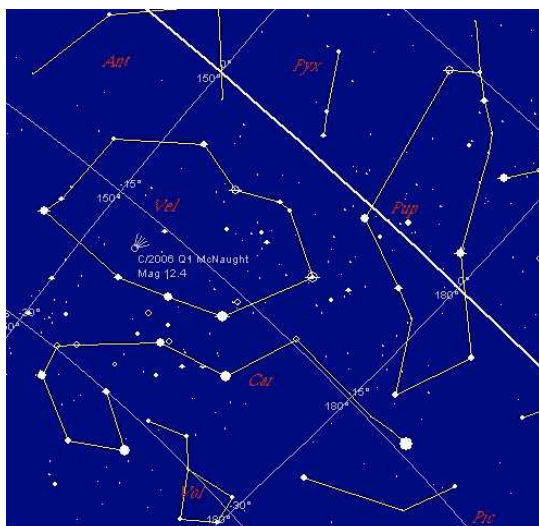
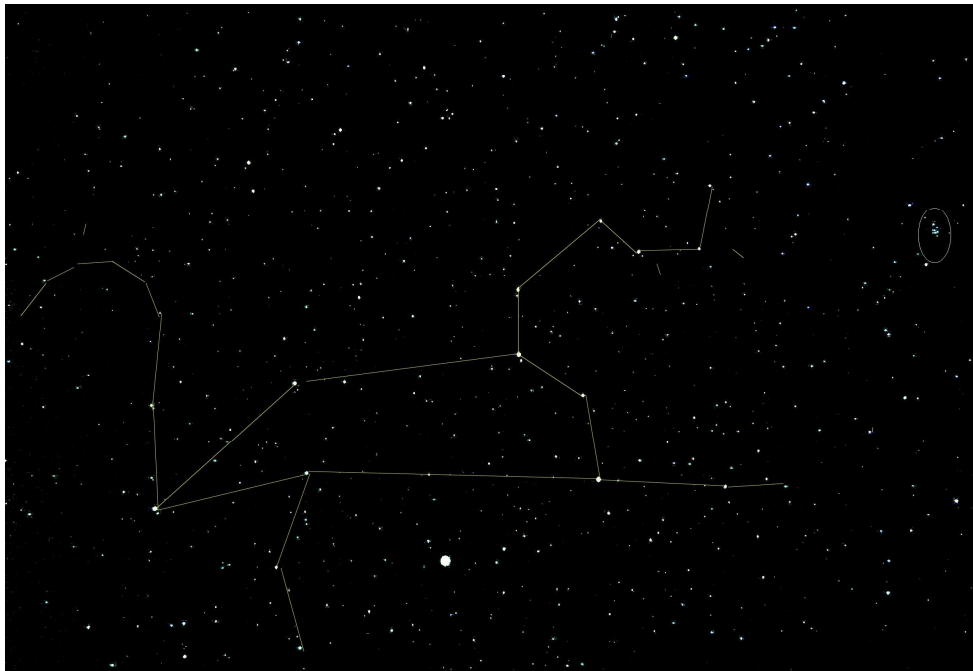
instruments. It lives on in the January Quadrantid meteor shower.



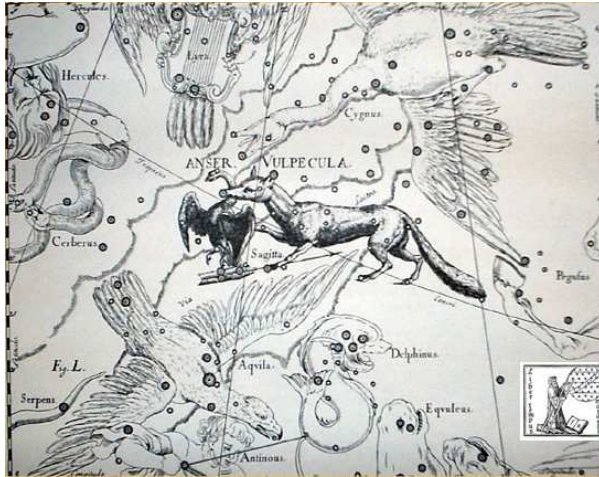
In Ptolemy's time Leo was very much larger than he is now, stretching from his whiskers in the Beehive Cluster to his tail in the wispy cluster of Coma Berenices, also known as the veil belonging to Thisbe, the girl thought by her lover Pyramus to have been eaten by a lion. This much larger constellation makes a lot of sense. Alpha Leonis, Regulus, is also known as Cor Leonis - the heart of the lion.

Look at our modern lion and it's at the top of his front leg, not in his chest where it should be.

Caspar Vopel and Gerardus Mercator (he of the maps fame) separated Coma Berenices from Leo in the mid 16th century.

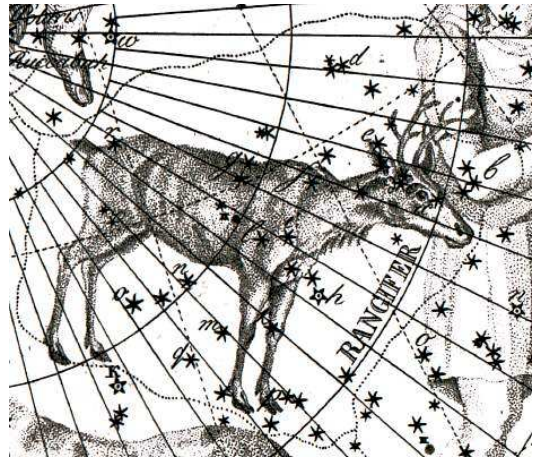


De Lacaille dismantled Argo Navis, the mighty ship of Jason and the Argonauts from Greek mythology, into Carina (the keel), Puppis (the poop), Vela (the sails) and Pyxis (the compass). It is the only one of Ptolemy's original constellations that is not recognised in any form.



Little Vulpecula, the fox, was originally Vulpecula and Anser - the fox and the goose - or rather the fox that had caught a goose for dinner.

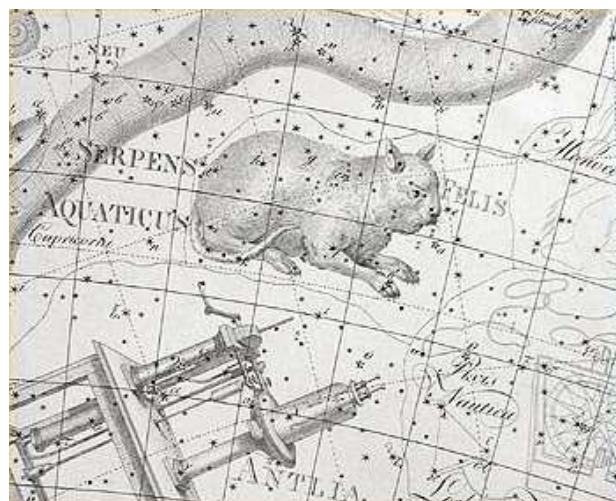
The reindeer appeared on a chart by Pierre-Charles de Monnier in 1743. It was placed near the north celestial pole - no surprises there - and commemorated a trip to Lapland to measure the length of a degree latitude in the far north.



And finally.

My own favourite failed constellation is Felis, the cat. This was published by Bode in Uranographia, but had been suggested to him a couple of years earlier by de Lalande. Bode said of his constellation - 'I love cats very much. I will have this picture engraved on the star map. The starry sky has made me tired enough all my life to allow me to have a little fun now.'

I think that alone makes a good case for its reinstatement. Any astronomer will empathise with him.



Below I have listed the star atlases I referenced in writing this article. Many are reproduced on the internet and are well worth a browse through. For a general overview of constellation lore search on Ian Ridpath's Star Tales.

Johann Bayer	Uranometria	1603	
Johannes Hevelius	Prodromus Astronomiae	1690	
John Flamsteed	Atlas Coelestis		1729
John Flamsteed	Atlas Celeste	1776	
Christian Goldbach	Neuester Himmels	1799	
Johann Elert Bode	Uranographia	1801	