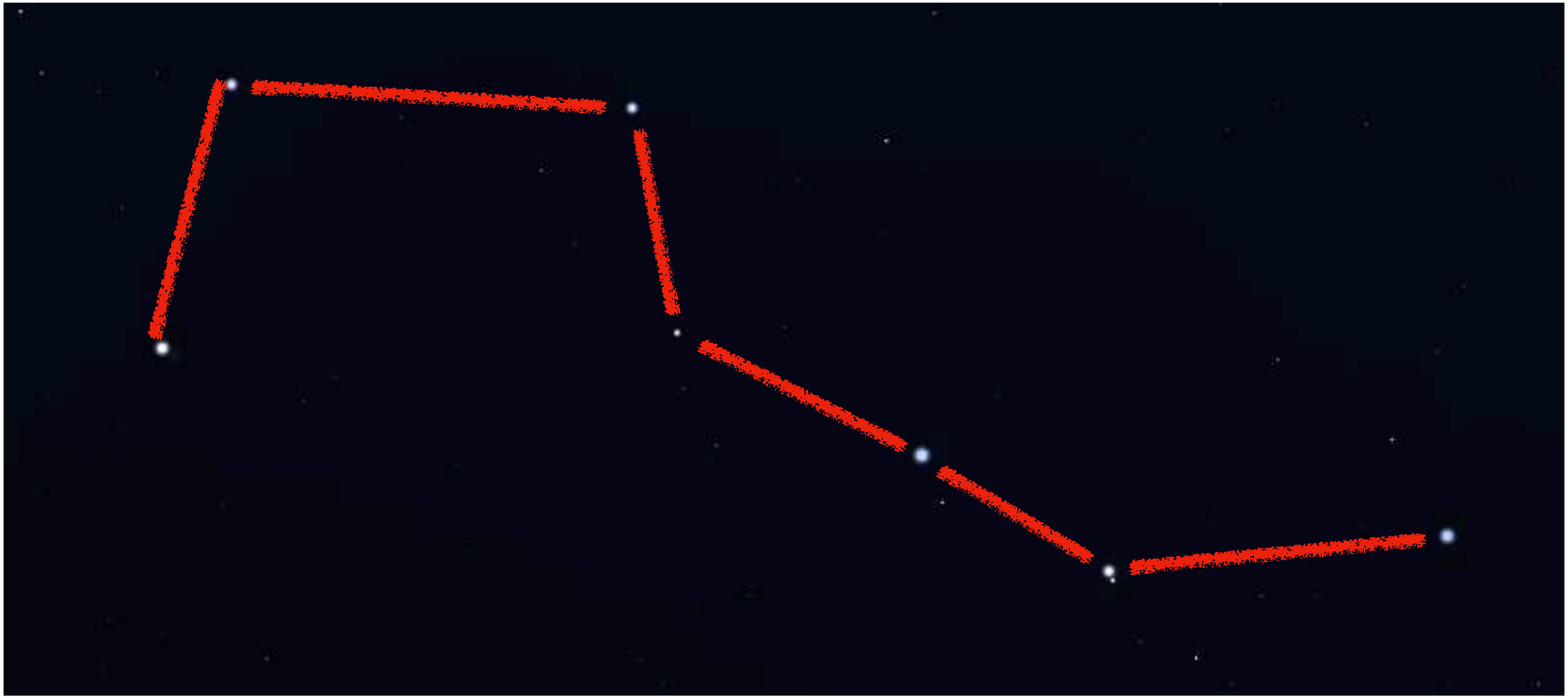
What do you call this “group of stars” ?

This is a familiar pattern of stars seen in the northern hemisphere !

“Group of stars” = The Big Dipper or Plow

This is the BIG DIPPER as seen about 11:00 p.m. in late March

“Asterism” = The Big Dipper or Plow



The BIG DIPPER is an asterism (star-group) not a constellation!

Constellation: one of 88 **regions** of the sky officially recognized by IAU International Astronomical Union

Asterism: informal familiar pattern or group of stars

Examples

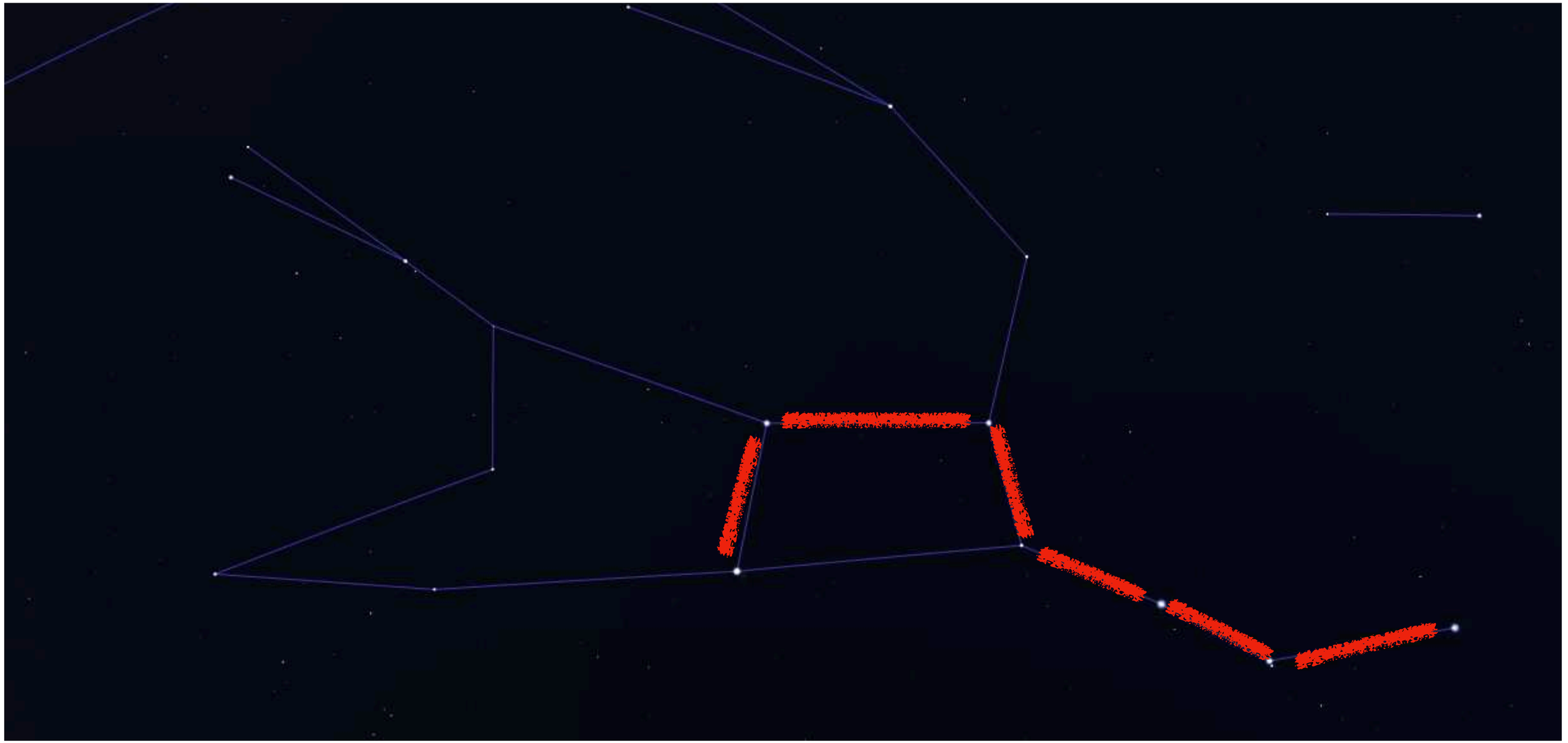
The Big Dipper is an asterism within The Big Bear (Ursa Major) Constellation region

Orion's Belt is an asterism within Orion the Hunter Constellation region

Ursa Major Constellation

Can you see The Big Dipper Asterism within Ursa Major (The Big Bear) ?

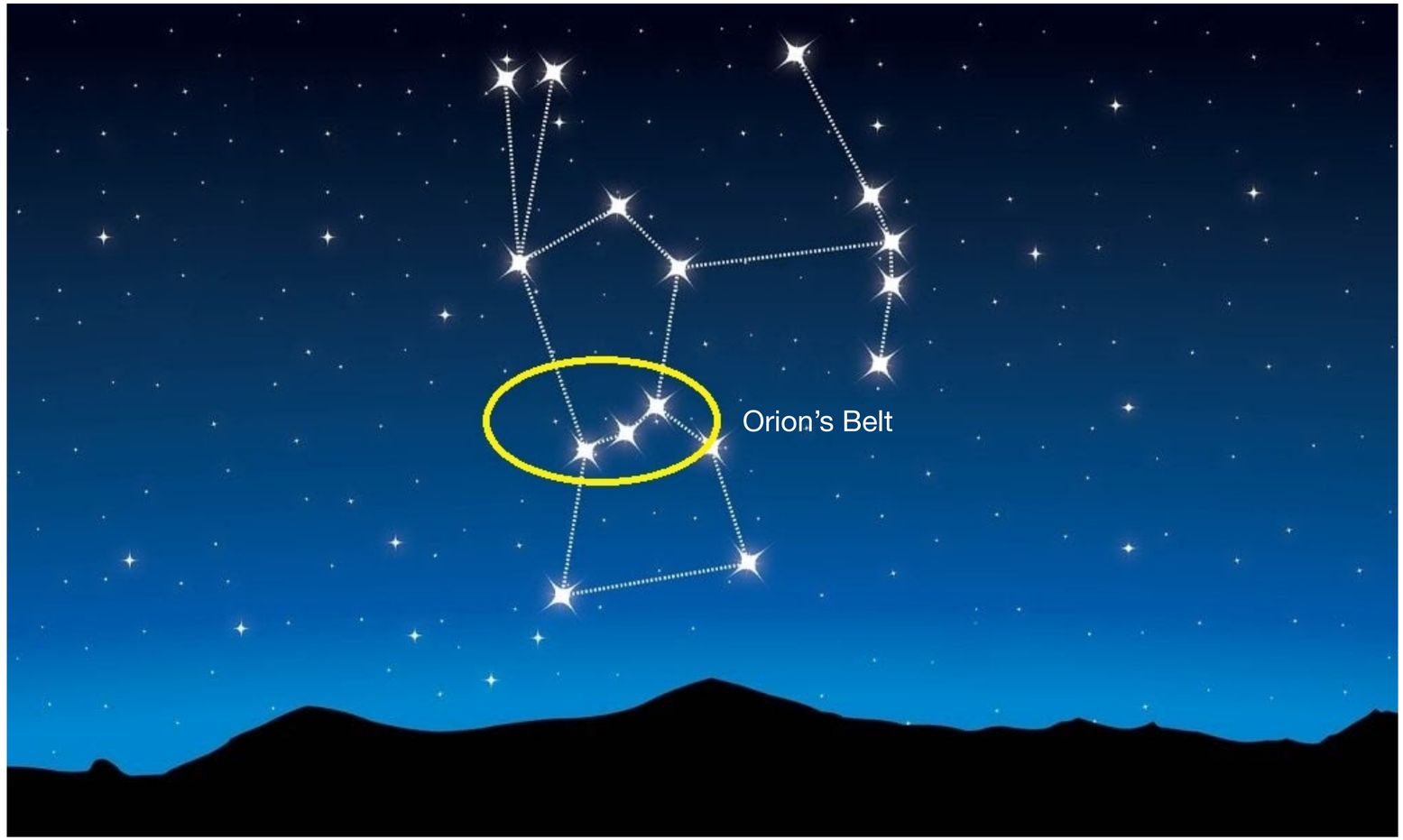
Ursa Major Constellation



The Big Dipper within Ursa Major

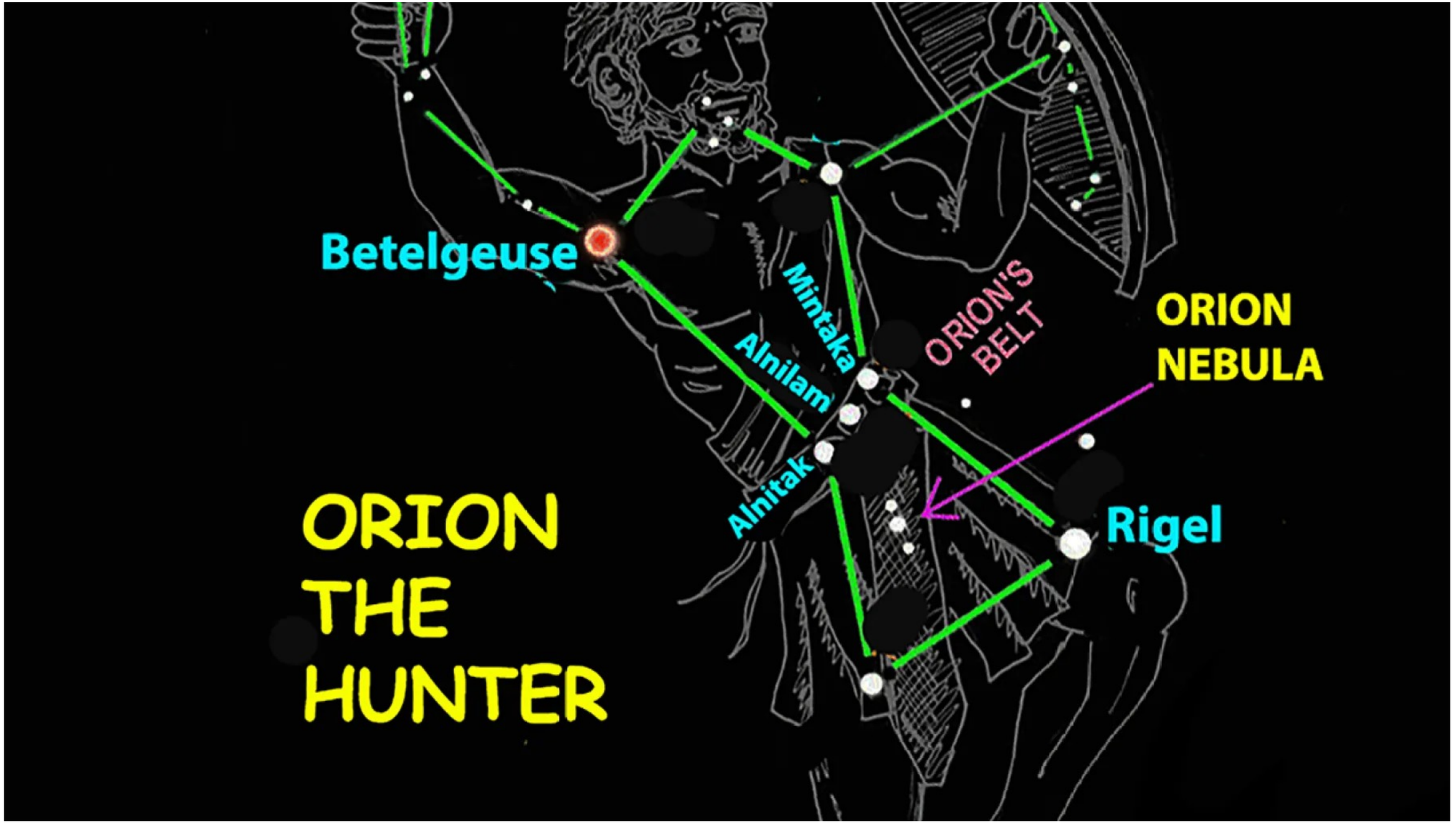
The Big Bear or Ursa Major Constellation Region with the Big Dipper

Orion Constellation (Winter)
can be seen in early evening to the west during March and April



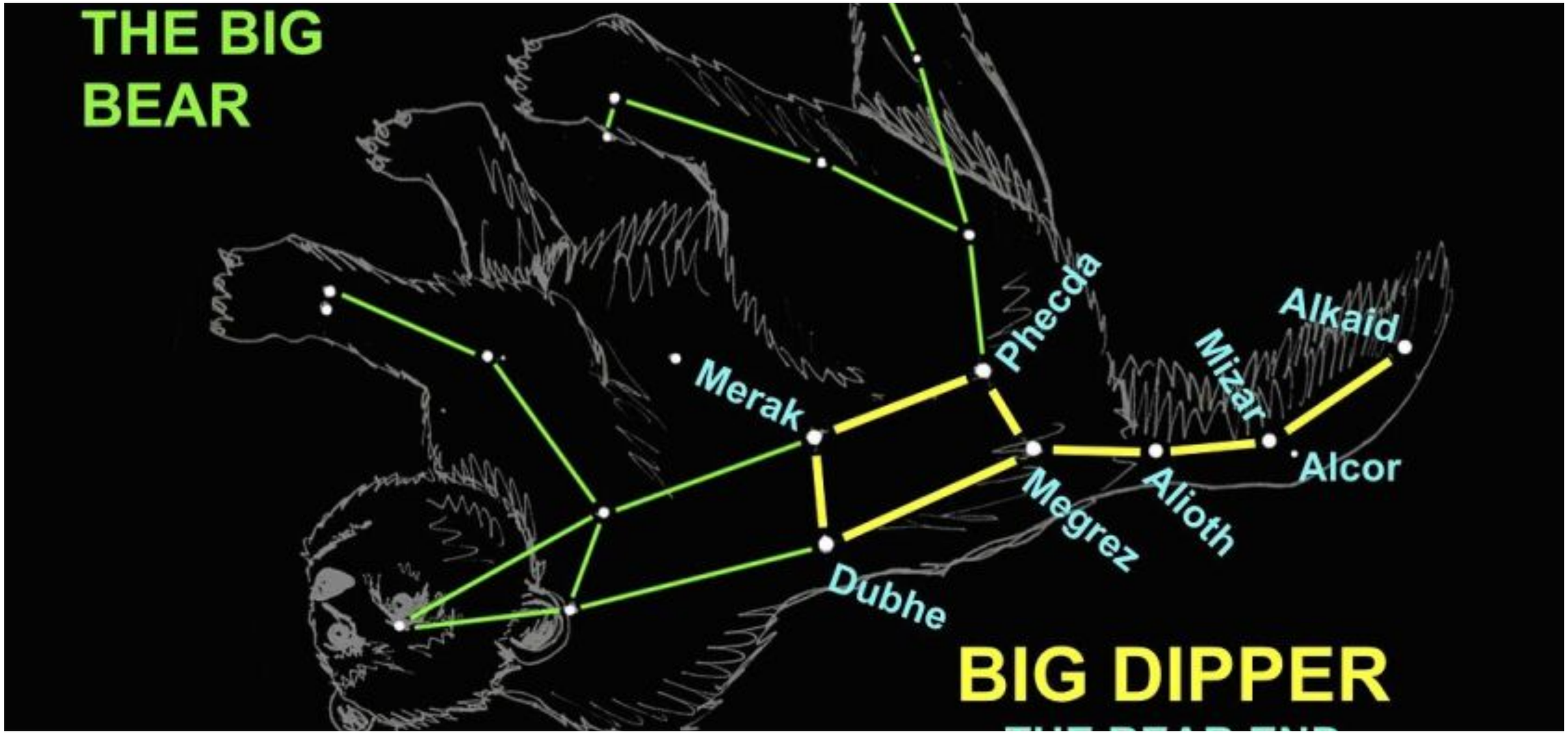
Orion's Belt is an asterism within the Orion Constellation Region

Can you see Orion the Hunter?



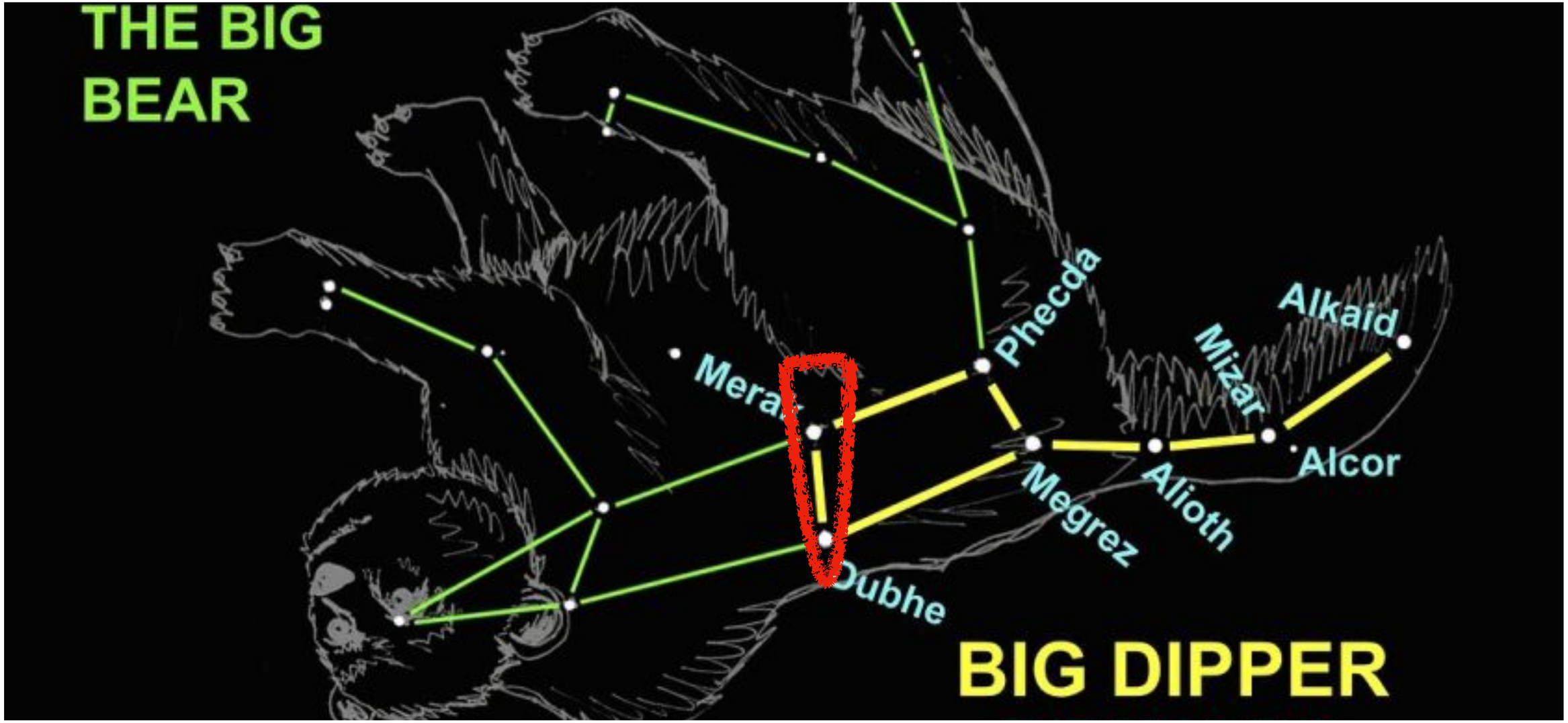
A more detailed look at Orion Constellation and its asterisms like Orion's belt and sword!

Let’s get back to the Big Bear and Big Dipper !

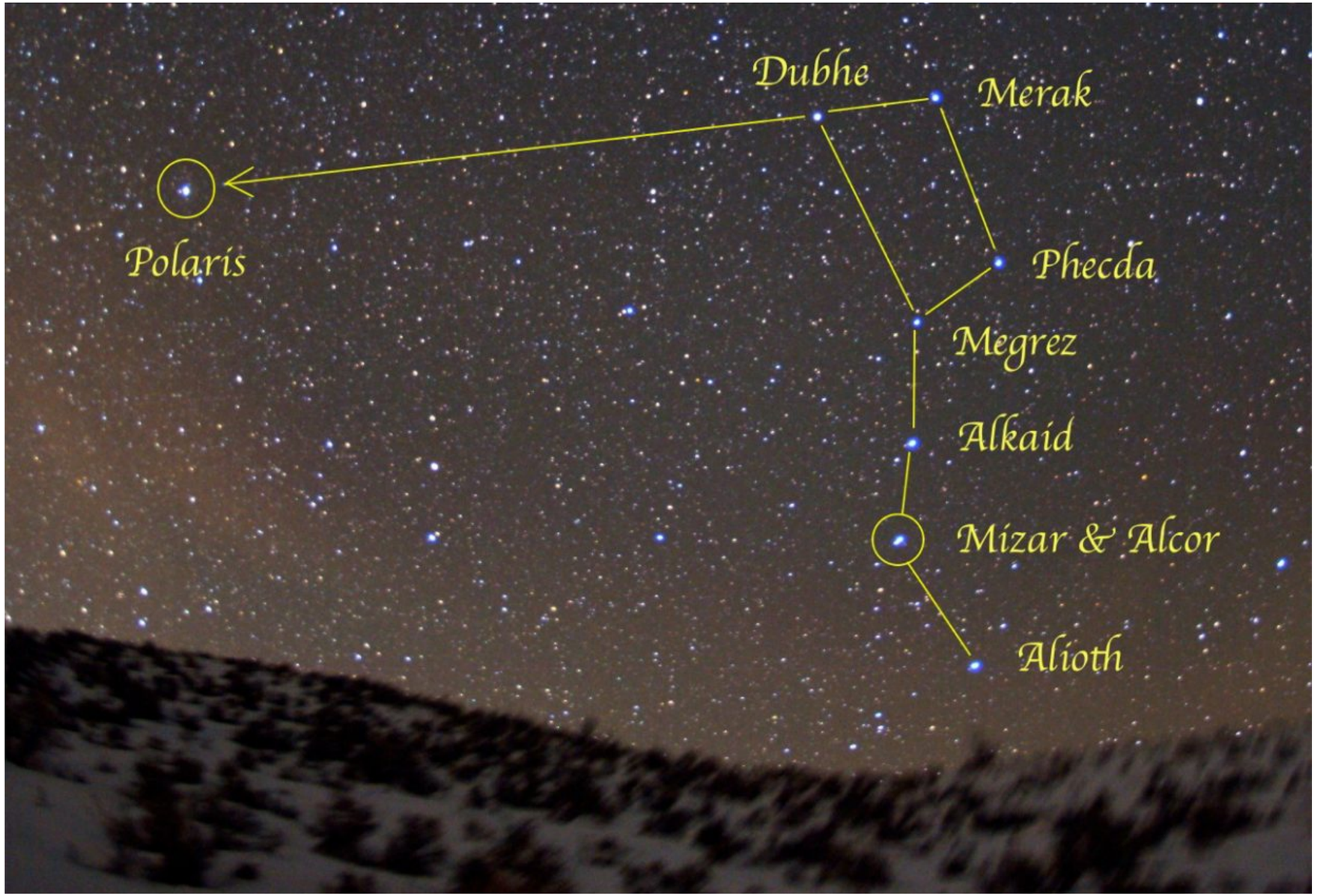


What were the two most important Big Dipper Stars to sailing ship navigators?

The Pointer Stars



The Pointer Stars: MERAK (loins) and DUBHE (back)



The Merak to Dubhe line always points to the North Star or Polaris!

The Lucky Stars:

Merak and Dubhe

Starting at Merak, five times the angular distance between Merak and Dubhe give the position of the North Star or Polaris !

Polaris is always **fixed** in the sky **directly north**!

The **angle of elevation** of Polaris always gives your **correct latitude**!

How does the Big Dipper change its orientation with the time of night and what season it is ?

For Stratford Ontario latitude,

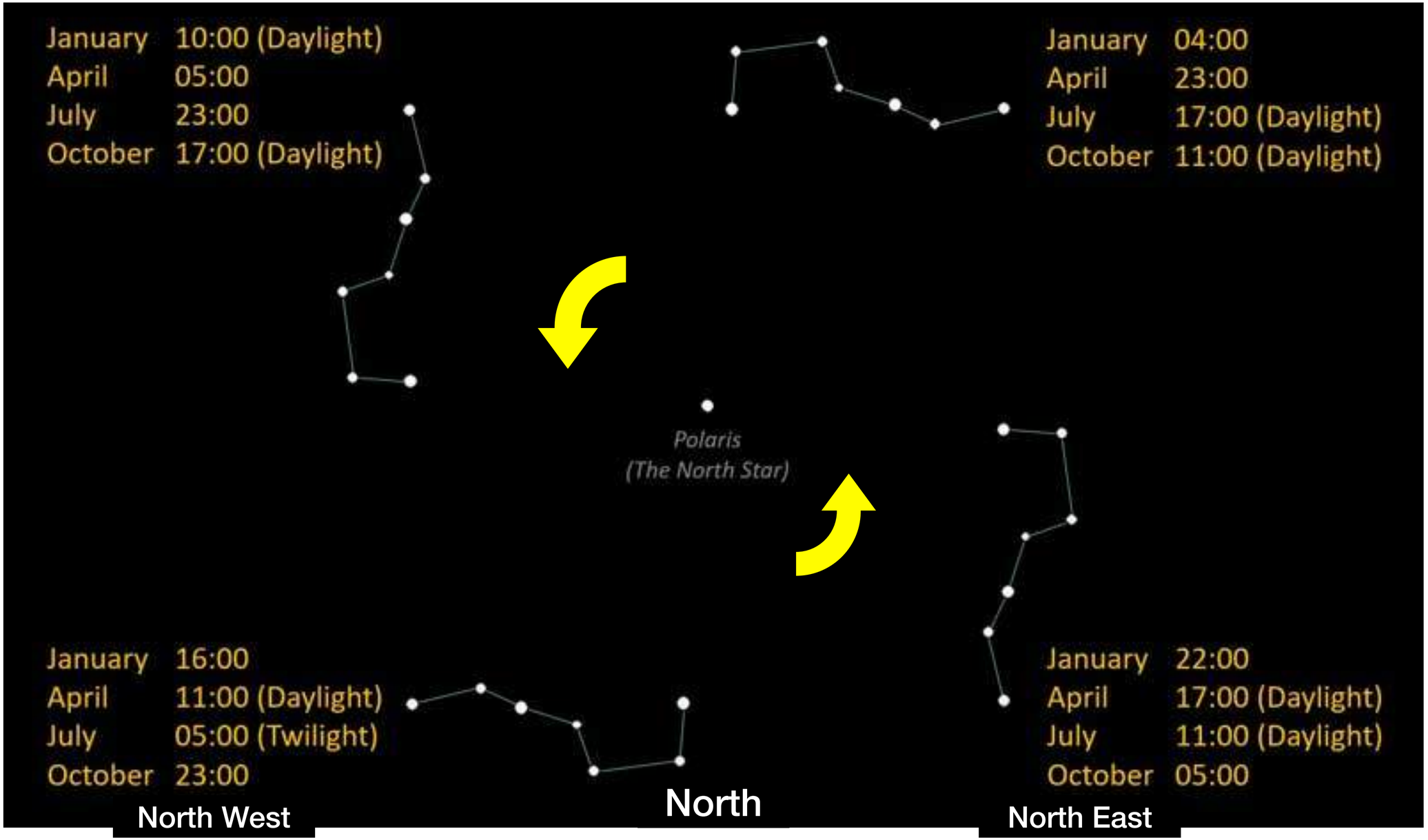
the Big Dipper is a circumpolar asterism.
This means…

It is close to the North Celestial Pole (Polaris or the North Star).
It circles counterclockwise around Polaris through the night.

It has a different starting position near Polaris with each season.

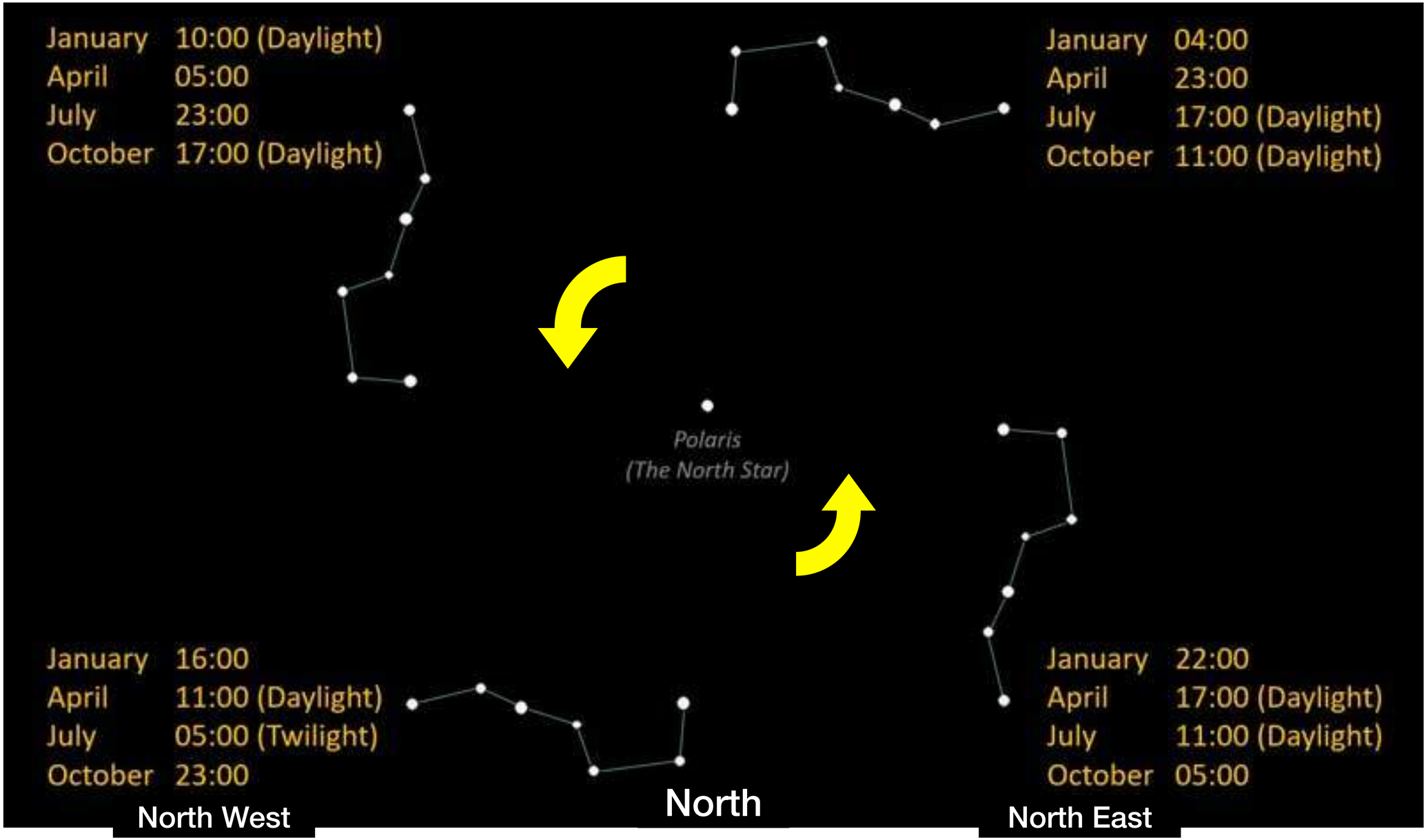
It is visible in the night sky all year round and never sets!

How does the Big Dipper change its orientation with the time of night and what season it is ?



At the latitude of Stratford Ont. of 43 degrees North, the Big Dipper has an apparent daily and seasonal night sky motion counterclockwise around Polaris!

How does the Big Dipper change its orientation with the time of night and what season it is ?



Why does the Big Dipper's starting position at 11 p.m. at night seem to be rotated a quarter turn from April to July?

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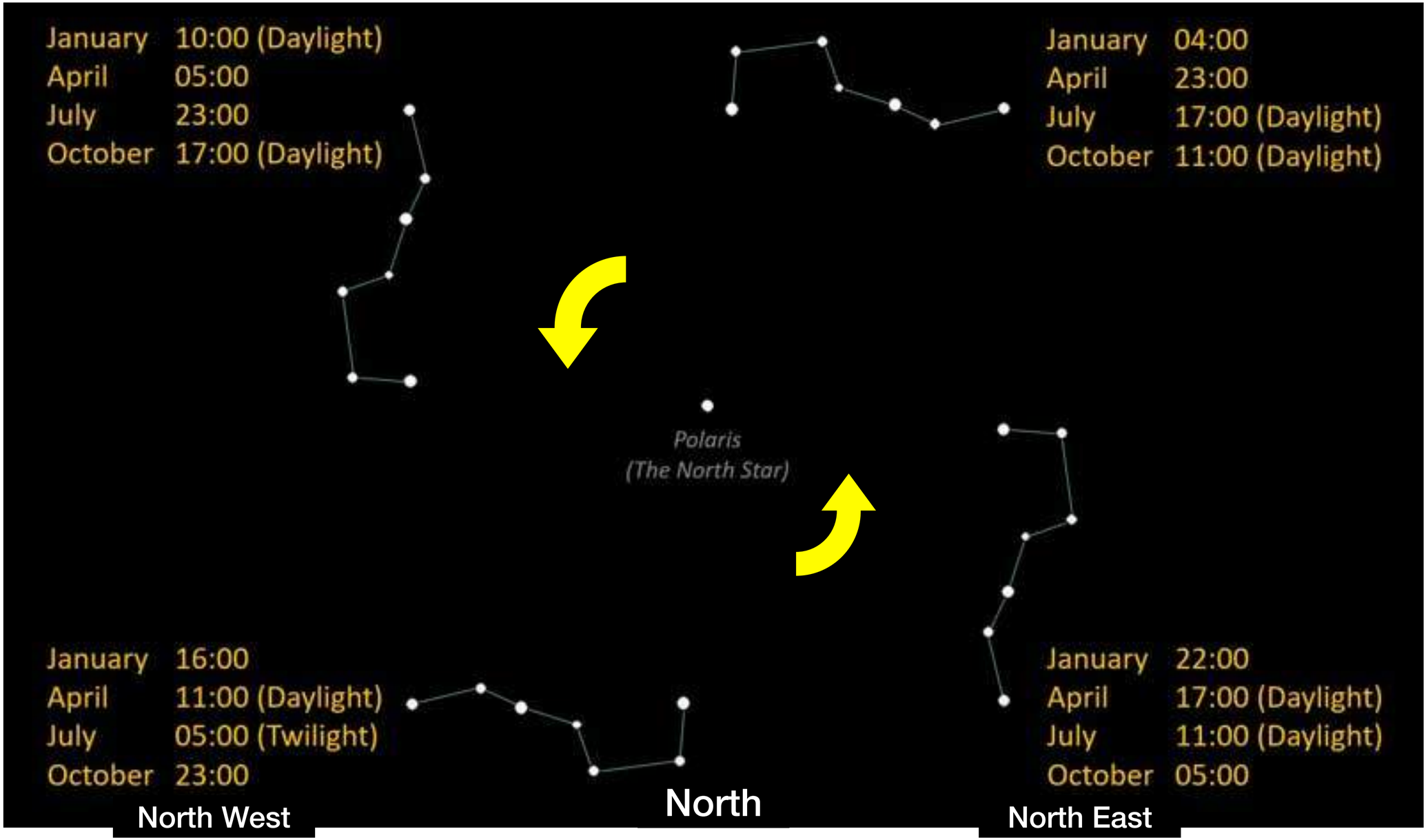
How does the Big Dipper change its orientation with the time of night and what season it is ?



Fact One

The Big Dipper and other stars only appear to rotate around Polaris. During the night, the earth rotates about its axis west to east. We think the stars are rotating, but it is actually the earth!

At the latitude of Stratford Ont. of 43 degrees North, the Big Dipper has an apparent daily and seasonal night sky motion counterclockwise around Polaris!

These star trails track stars, asterisms and constellations as they appear to move around Polaris during the night!

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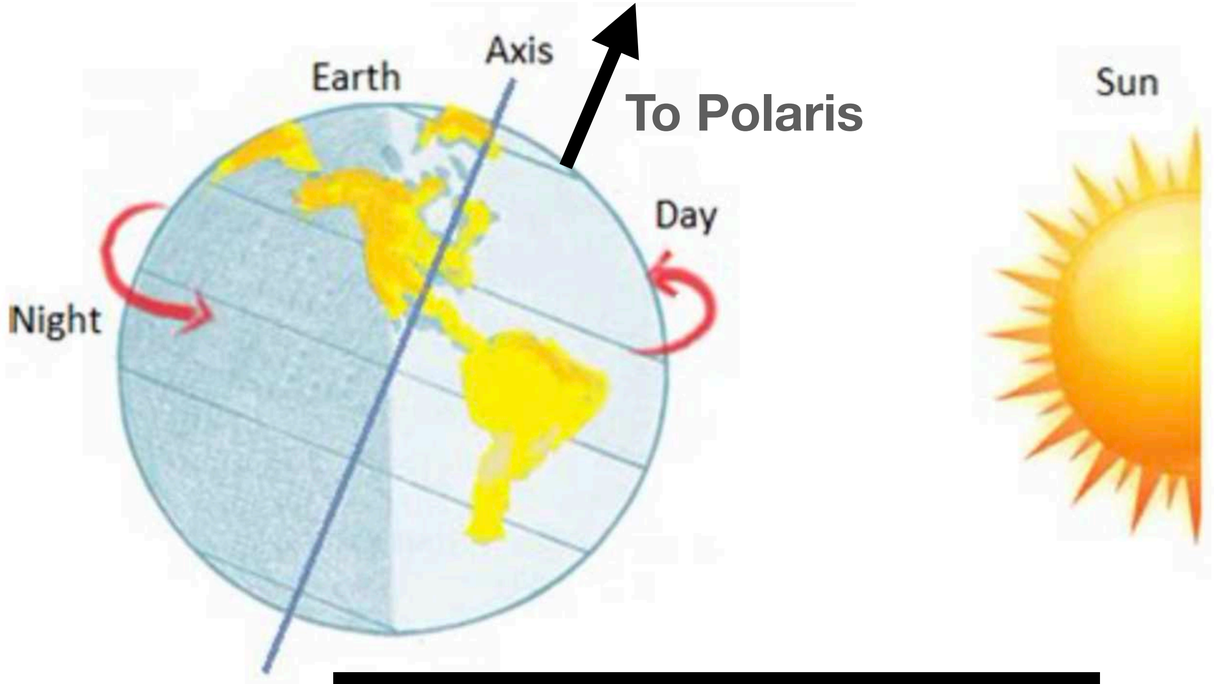
Fact Two

The earth rotates one full turn or 360 degrees about its axis every _____?



Earth's rotation
West to east
Every _____?

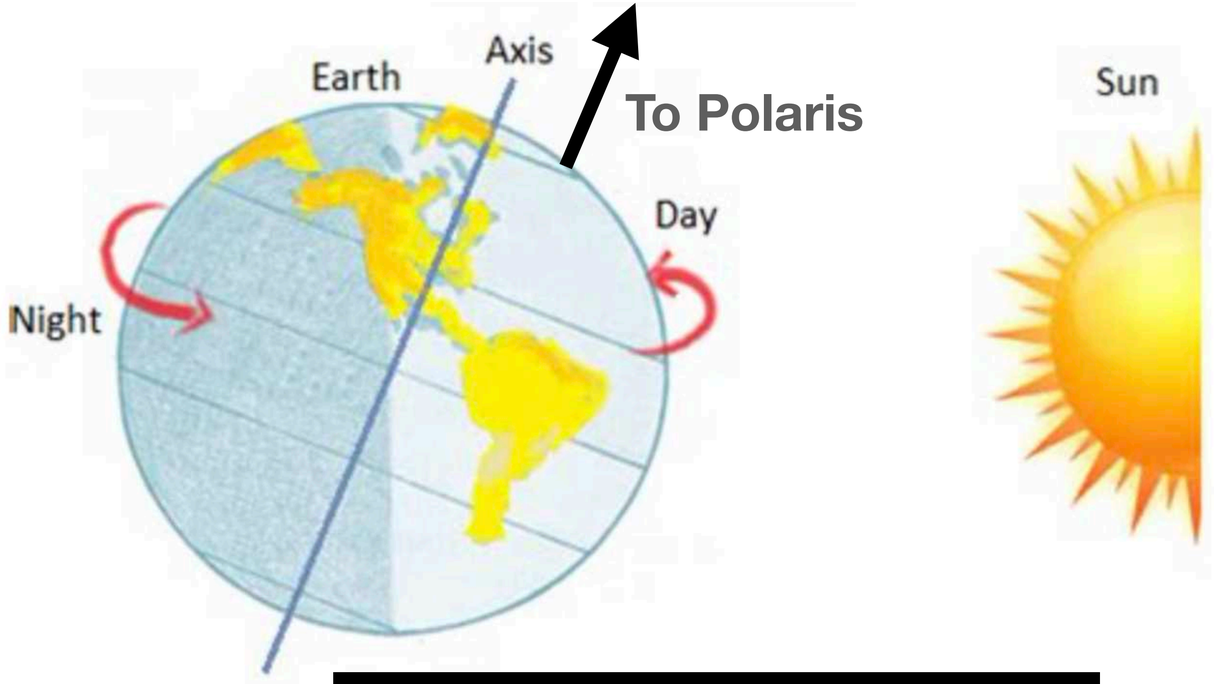
How long does it take the earth to make one complete turn?

Why does the Big Dipper's starting position at 11 p.m. at night seem to be rotated a quarter turn from April to July?

Fact Two

The earth rotates one full turn or 360 degrees about its axis every

23 hours 56 minutes



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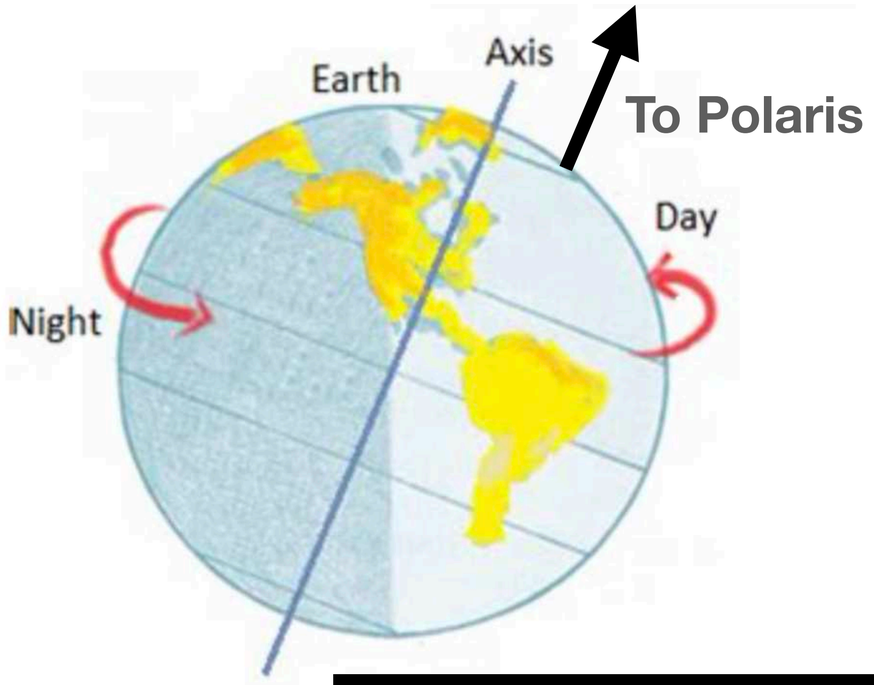


Earth's rotation
West to east
Every 23 hours 56 minutes

How long does it take the earth to make one complete turn?

Explanation

The earth is **also orbiting around the sun** as it is rotating! Since it moves about 1 degree around the sun in one day, **it has to rotate an extra degree or 361 degrees in total to line up with the sun again.**

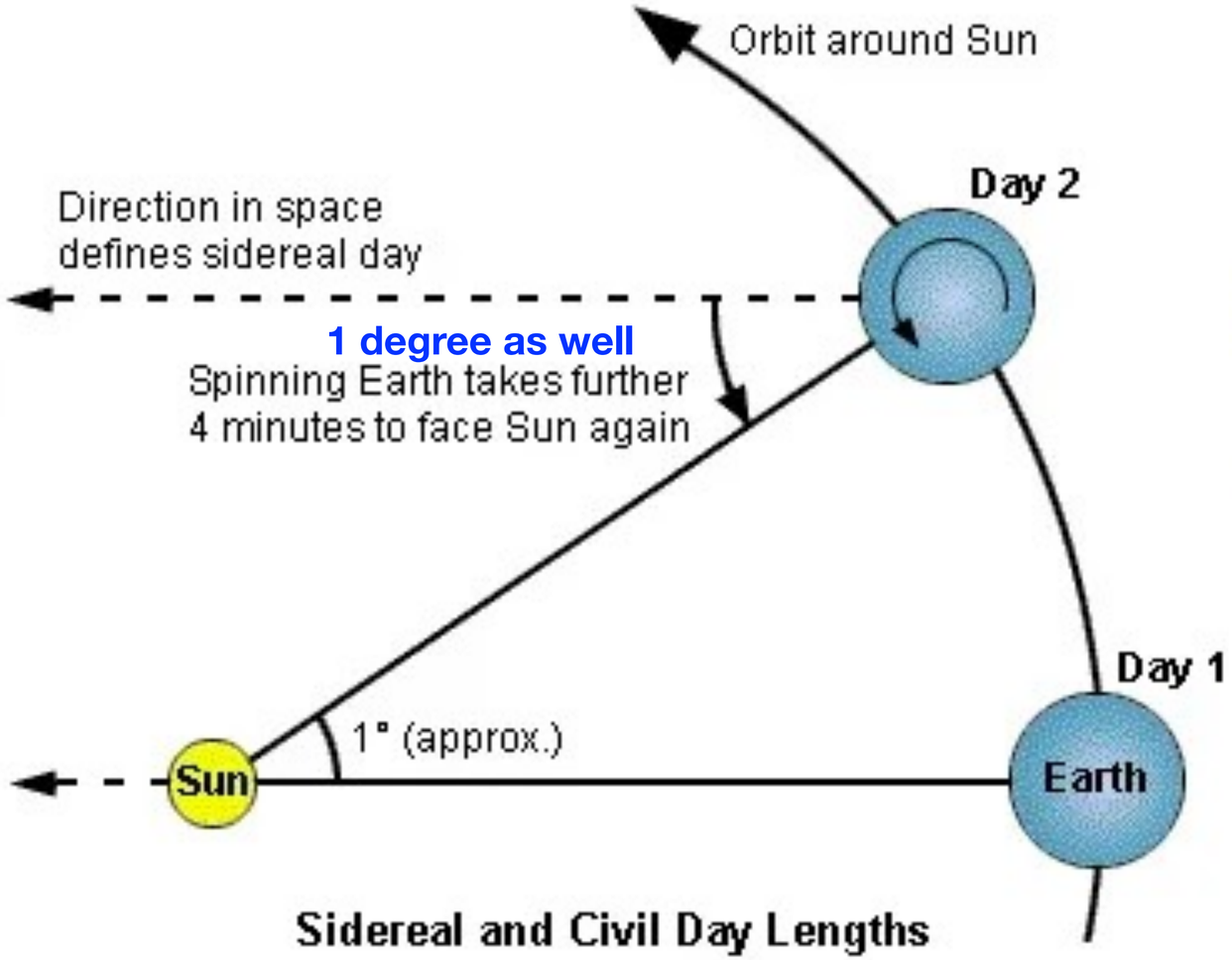
For the earth to rotate an extra one degree it takes an **additional 4 minutes.**

With respect to the very distant stars, the earth rotates once every **23 hours and 56 minutes**. This is called a **Sidereal day,** from the Latin "sidus" meaning "star".

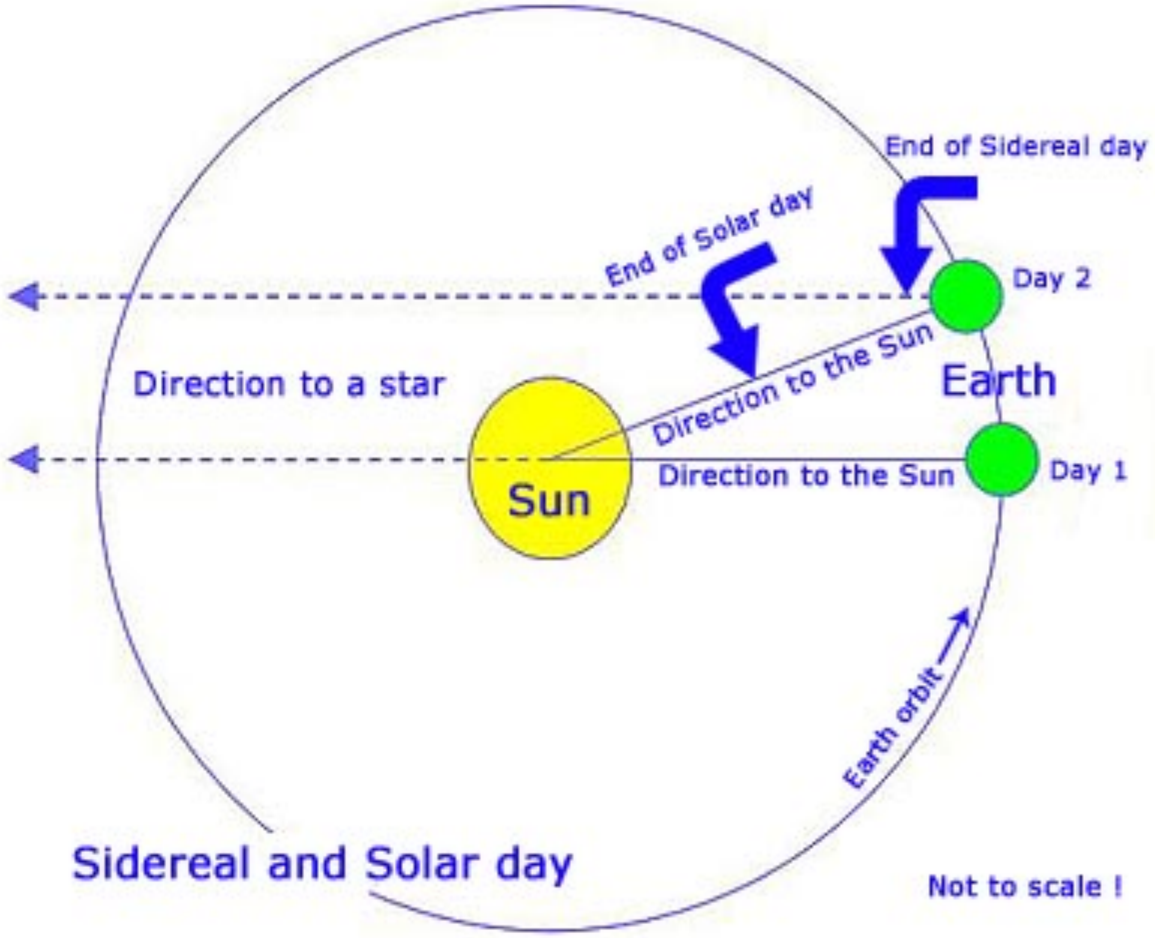
The Big Dipper's apparent motion makes a complete circle around Polaris **4 minutes earlier every night,** so its starting position moves a little more counterclockwise every night! Other non-circumpolar stars rise and set 4 minutes earlier every night!

With respect to the sun, the earth needs **24 hours** to line up with sun and rotate 361 degrees. This is a **Solar day** which is used by us for timekeeping.

Why stars seem to be 4 minutes early each night?



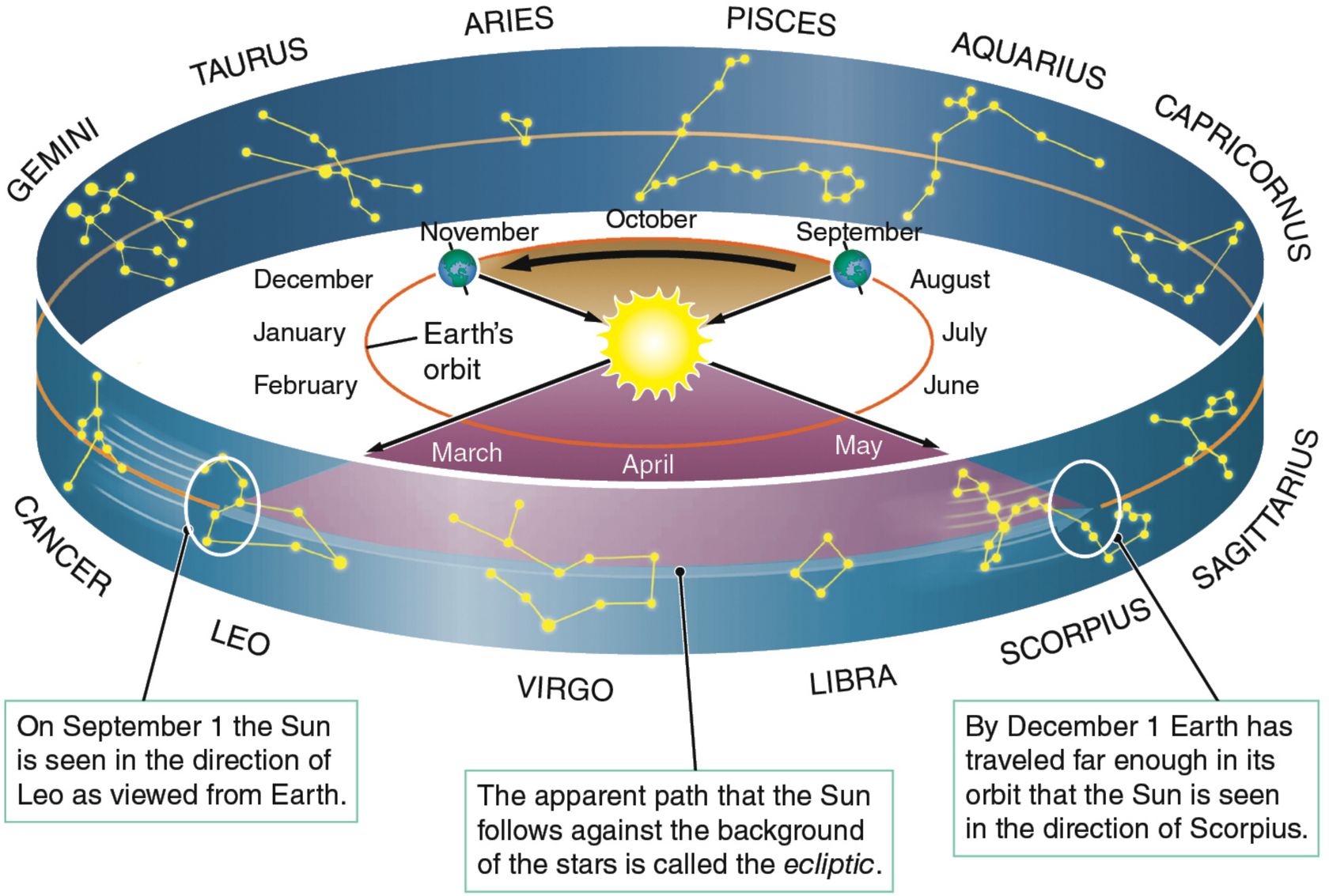
Sidereal vs Solar or Civil day : Diagram 1



Sidereal vs Solar day: Diagram 2

Unlike circumpolar asterisms like the Big Dipper, why are many constellations and asterisms seasonal and appear to rise (east) and set (west) ?

Unlike circumpolar asterisms like the Big Dipper, why are many constellations and asterisms seasonal and appear to rise (east) and set (west) ?

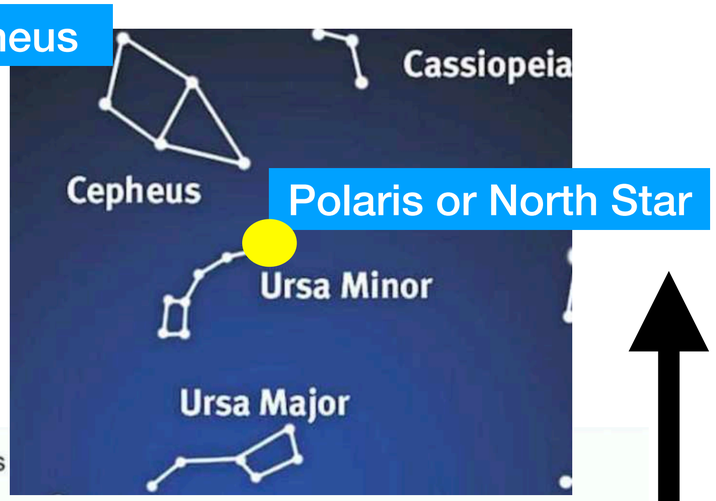


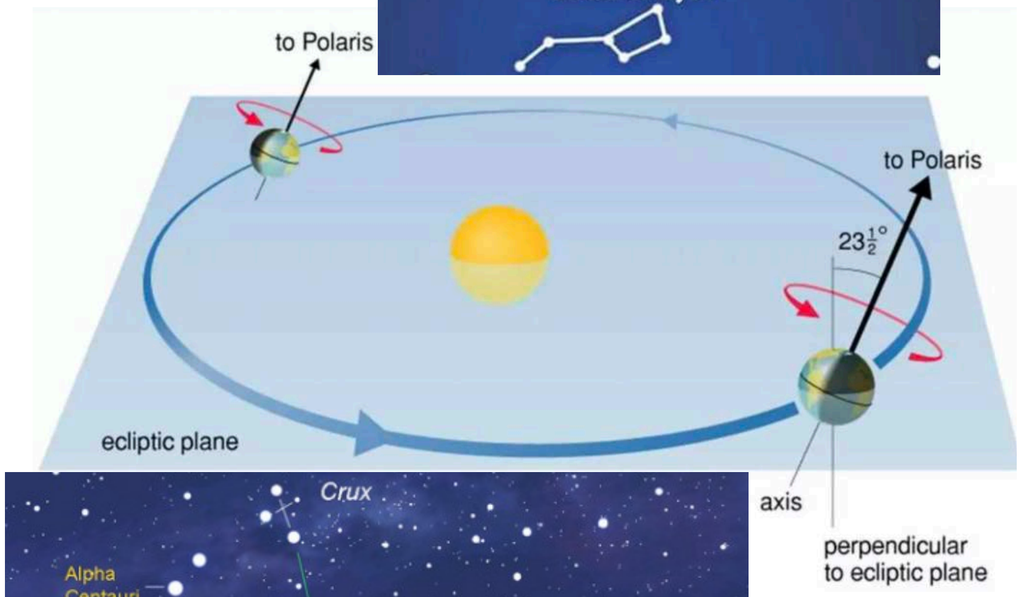
Constellations like the ZODIAC along the plane of the earth's orbit can only be seen on certain months by mid-latitude observers

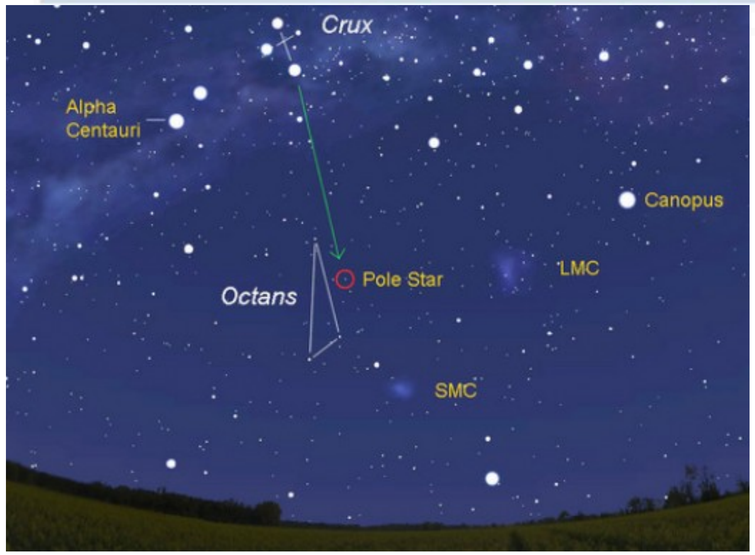
Northern Hemisphere Circumpolar Constellations and Asterisms

Seen in mid to high latitudes

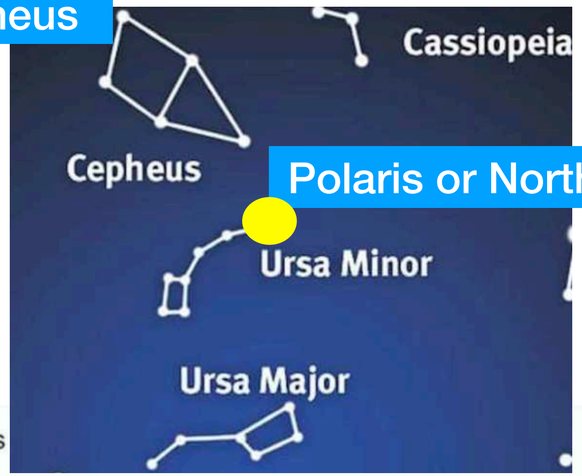
Located above the plane of earth's orbit







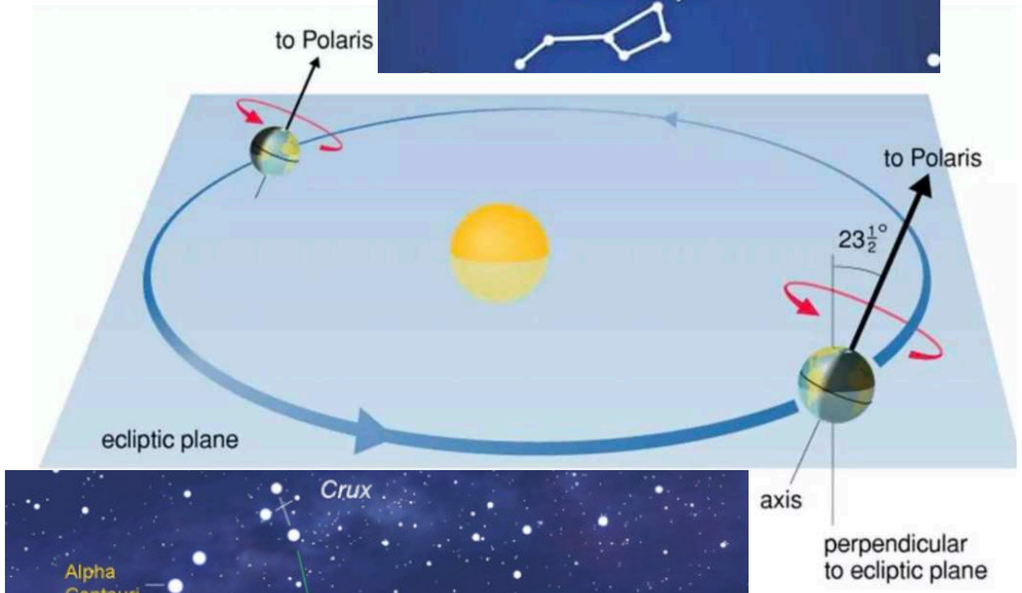
Delta Cepheus



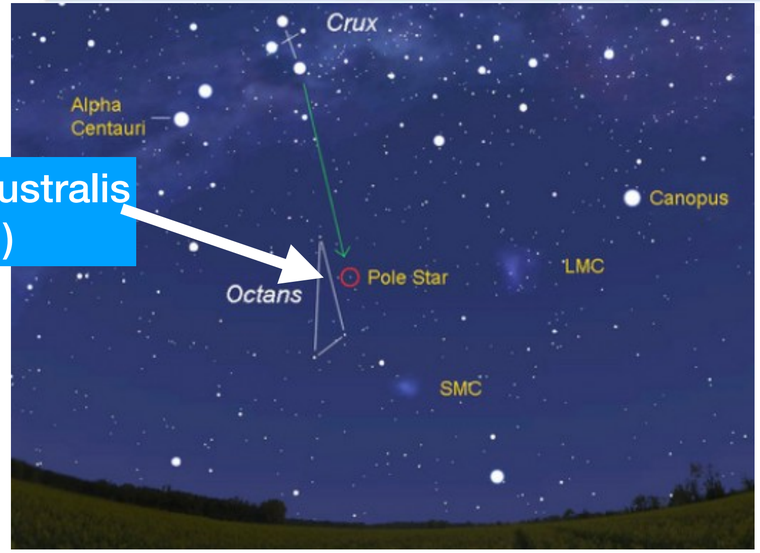
Northern Hemisphere Circumpolar Constellations and Asterisms

Seen in mid to high northern latitudes

Located above the plane of earth's orbit



Sigma Octantis or Polaris Australis
South Star (very dim)



Southern Hemisphere Circumpolar Constellations and Asterisms

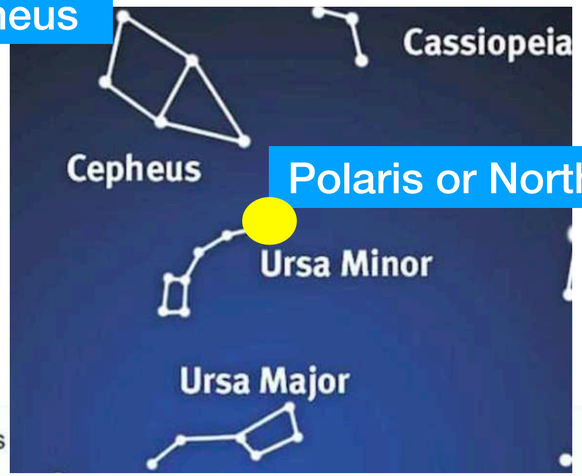
Seen in mid to high southern latitudes

Located below the plane of earth's orbit

Mid-Latitude NON-CIRCUMPOLAR Asterisms and Constellations

Located **along the plane** of earth's orbit

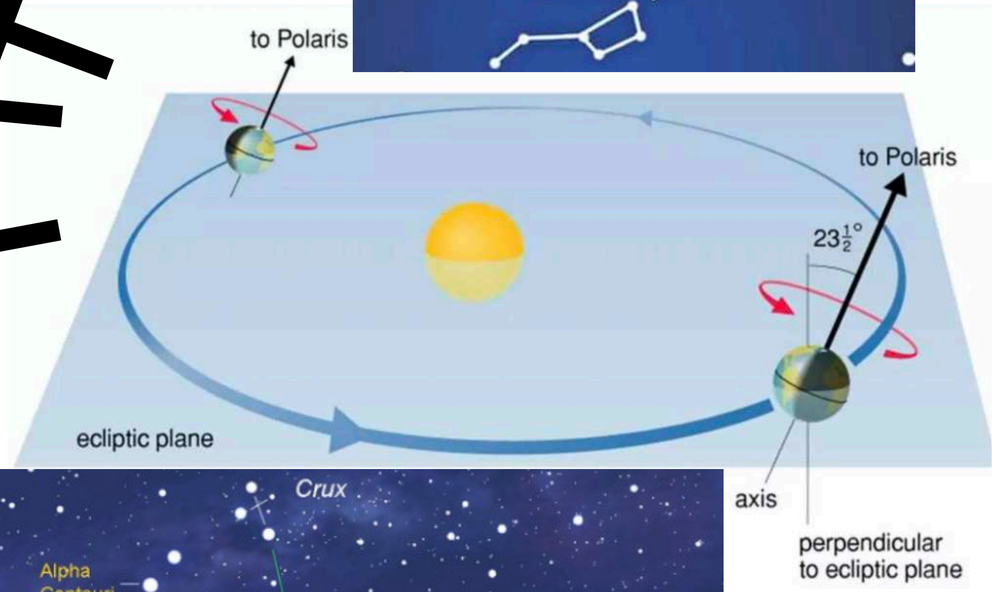
Delta Cepheus



Northern Hemisphere Circumpolar Constellations and Asterisms

Seen in mid to high northern latitudes

Located **above the plane** of earth's orbit



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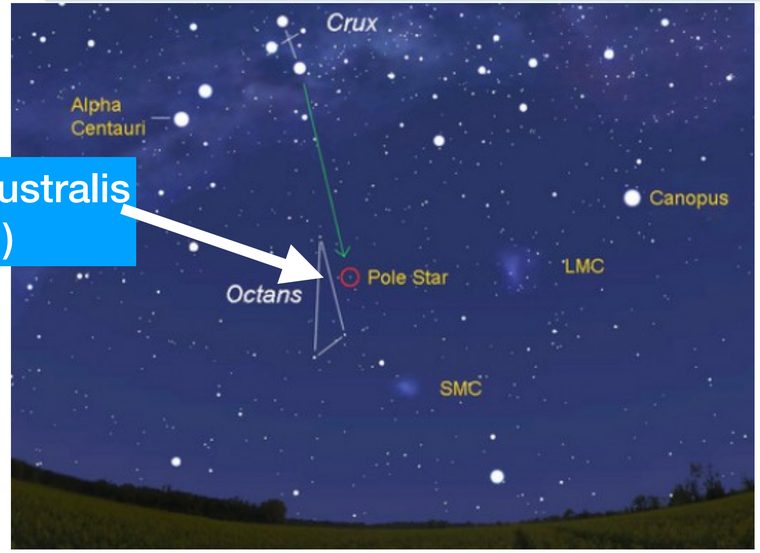


Southern Hemisphere Circumpolar Constellations and Asterisms

Seen in mid to high southern latitudes

Located **below the plane** of earth's orbit

Facts About Our North Star (Polaris Aa)

Polaris is part of a gravitationally-bound **triple star system** and part of Ursa Minor Constellation or "The Little Bear". It is also part of the asterism "Little Dipper" !

It is the closest **Cepheid variable star.** Cepheids are used to find distances to distant galaxies. Look up Henrietta Leavitt to learn more. It is 446 light years from us!

Polaris Aa is a yellow, unstable dying supergiant 2000X brighter than the sun and 6 times more massive, soon to be a red giant. It **varies in brightness** regularly every 4 days.

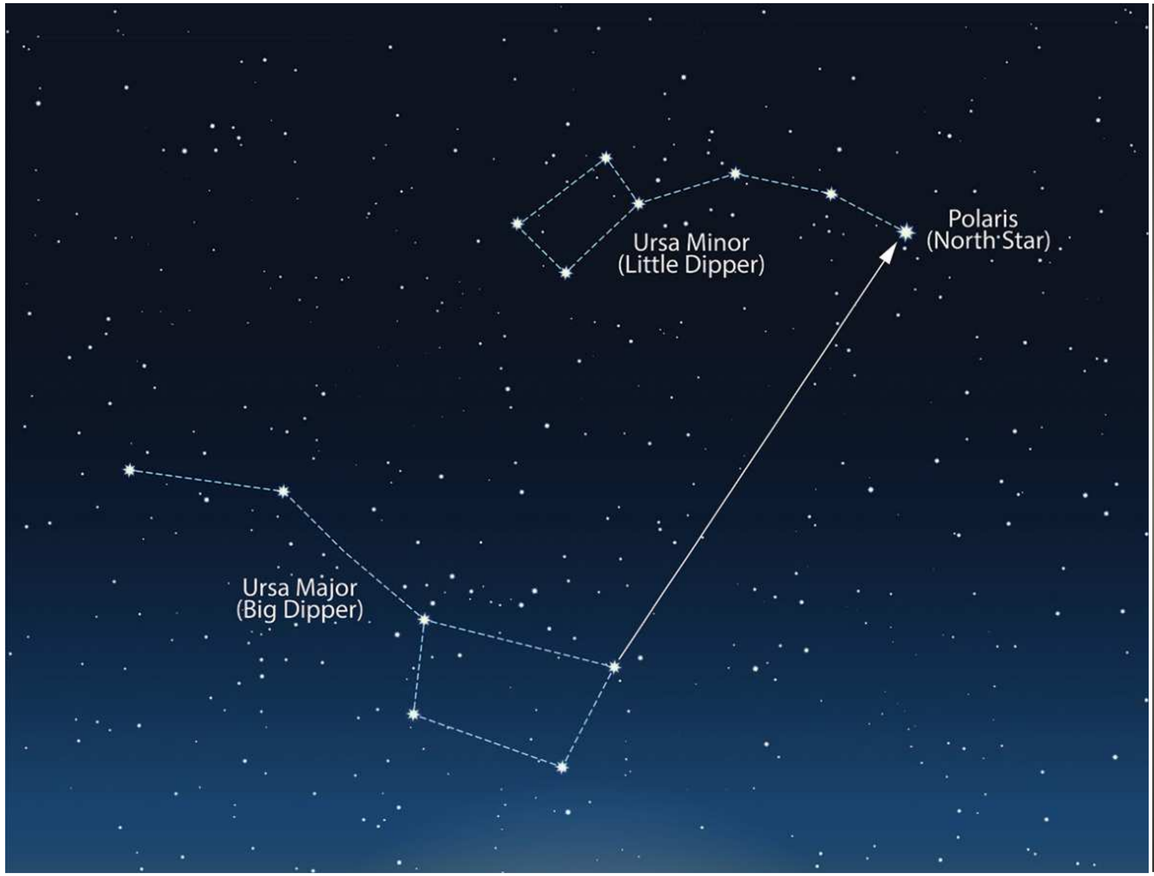
Polaris Aa is just a little hotter than the sun at its surface. (6000 K or an F type star)

Because it is not too close it appears **bright enough to see with the naked eye**, but it is only the 48th brightest star. Sirius and Canopus are far brighter!

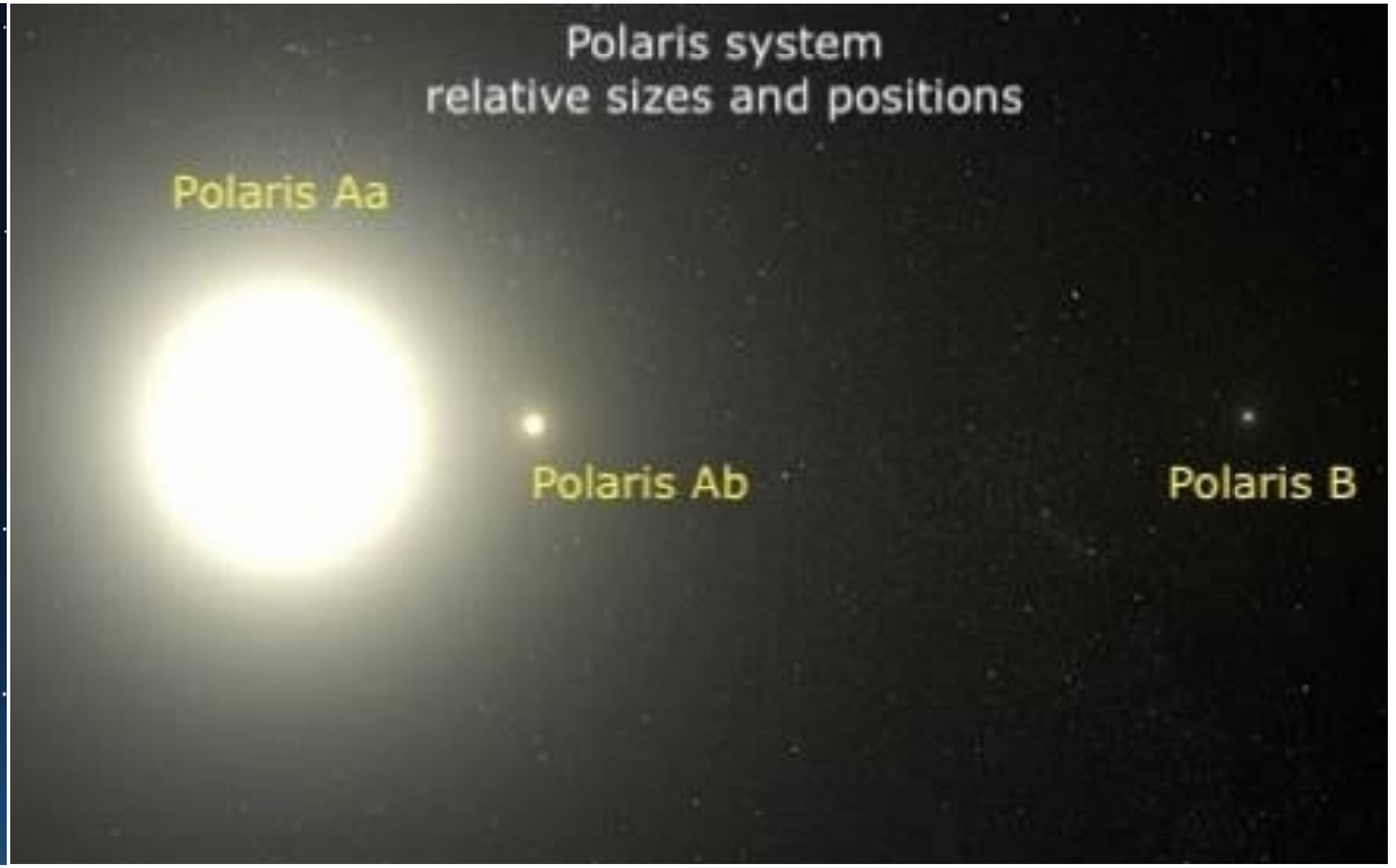
A close companion **Polaris Ab**, about 1.3 solar masses, orbits around Polaris Aa every 30 years. It is stable and a little hotter than the sun. (F type star)

A more distant stable F type star called **Polaris B** about 1.4 solar masses orbits Polaris Aa and Ab.

The angle of elevation of Polaris is always equal to its latitude! From Stratford, The angle of elevation to Polaris is 43.4 degrees, which is also its North latitude.



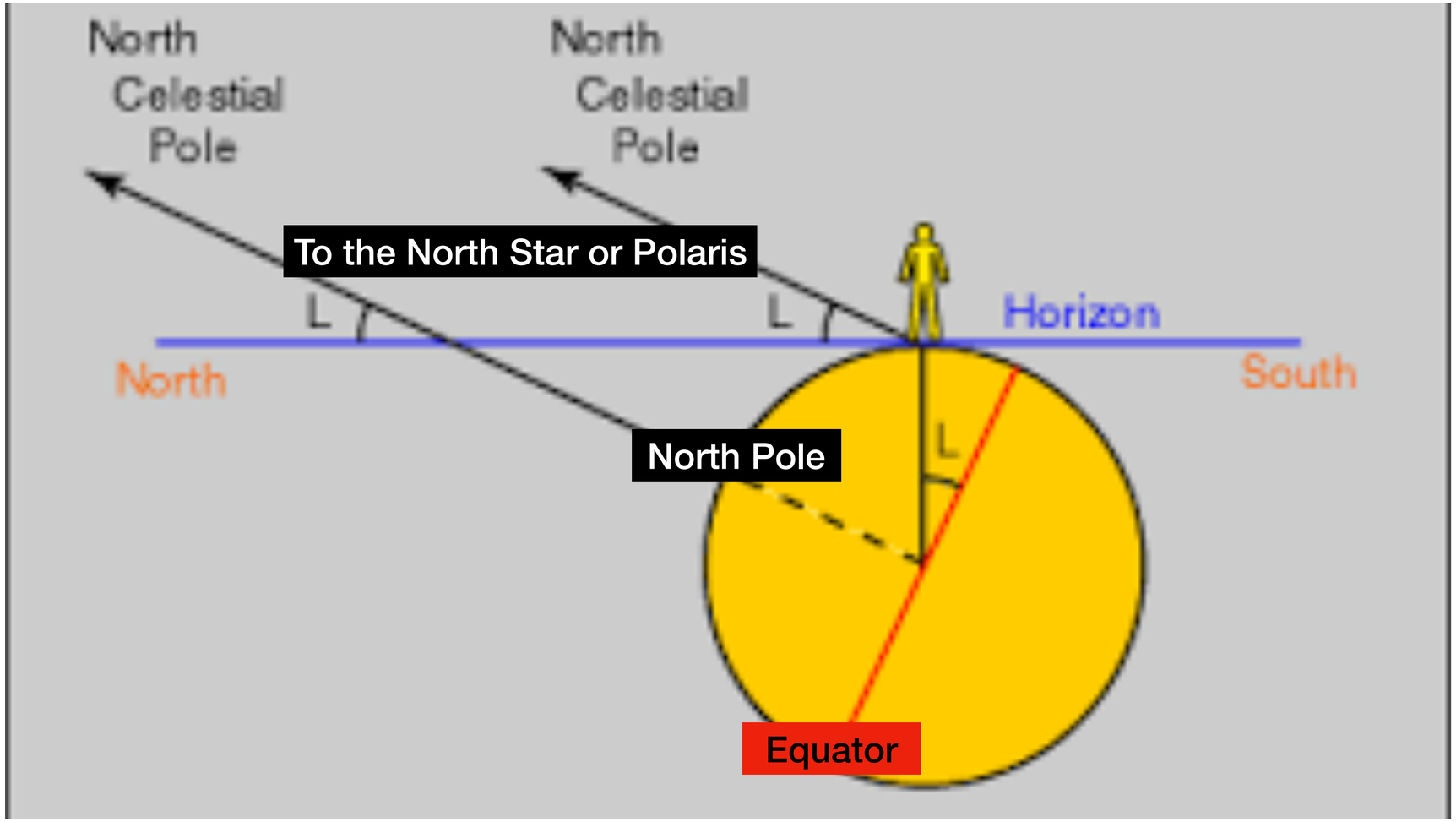
Polaris Aa as part of the Little Dipper



Polaris Aa or the North Star is part of a triple star system! Only Polaris Aa can be seen with the naked eye.

Why is Polaris’ elevation angle equal to the latitude?

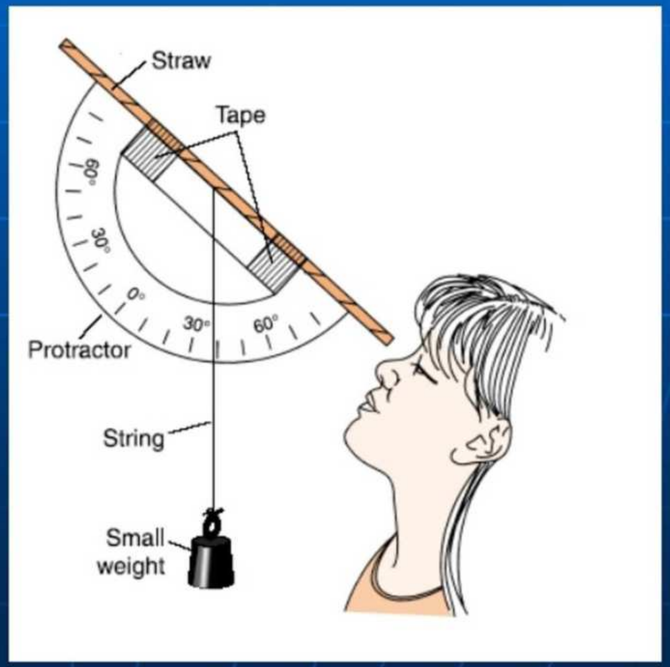
Why is Polaris' elevation angle equal to the latitude?



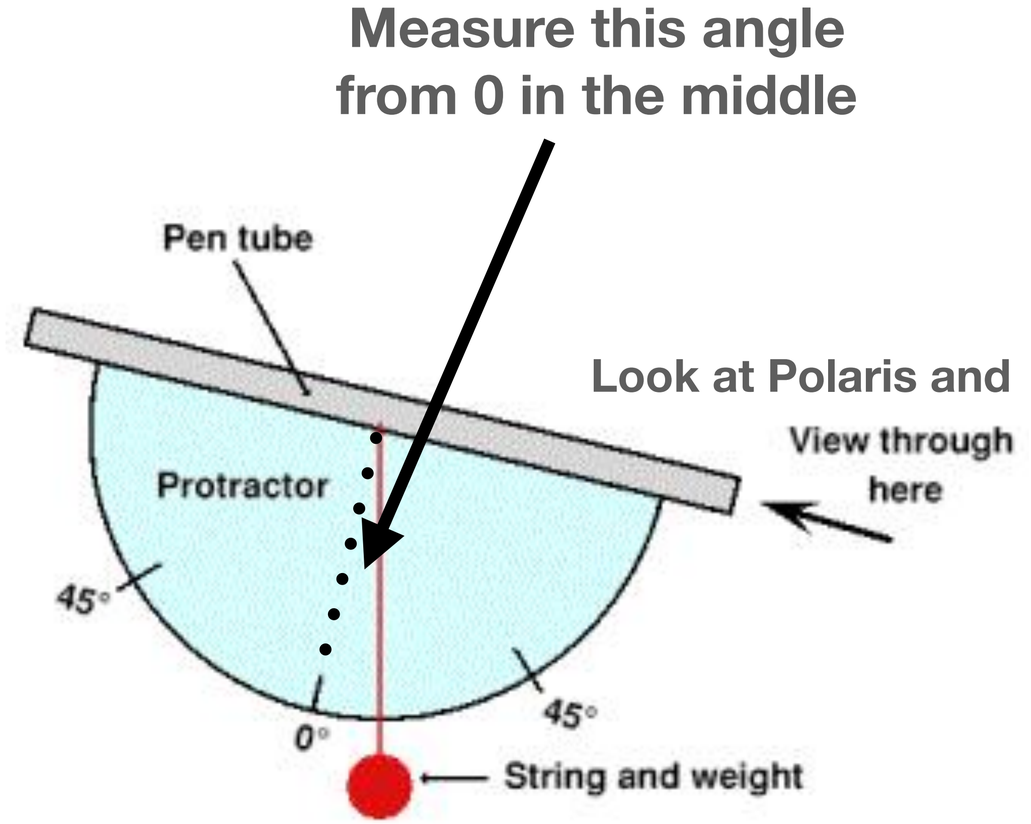
Simple geometry of parallel lines and sum of angles in a triangle prove why Polaris has been so helpful to earth navigators for 1500 years!

How to Make your own Latitude-Measuring Device called an "Astrolabe" or "Clinometer" .

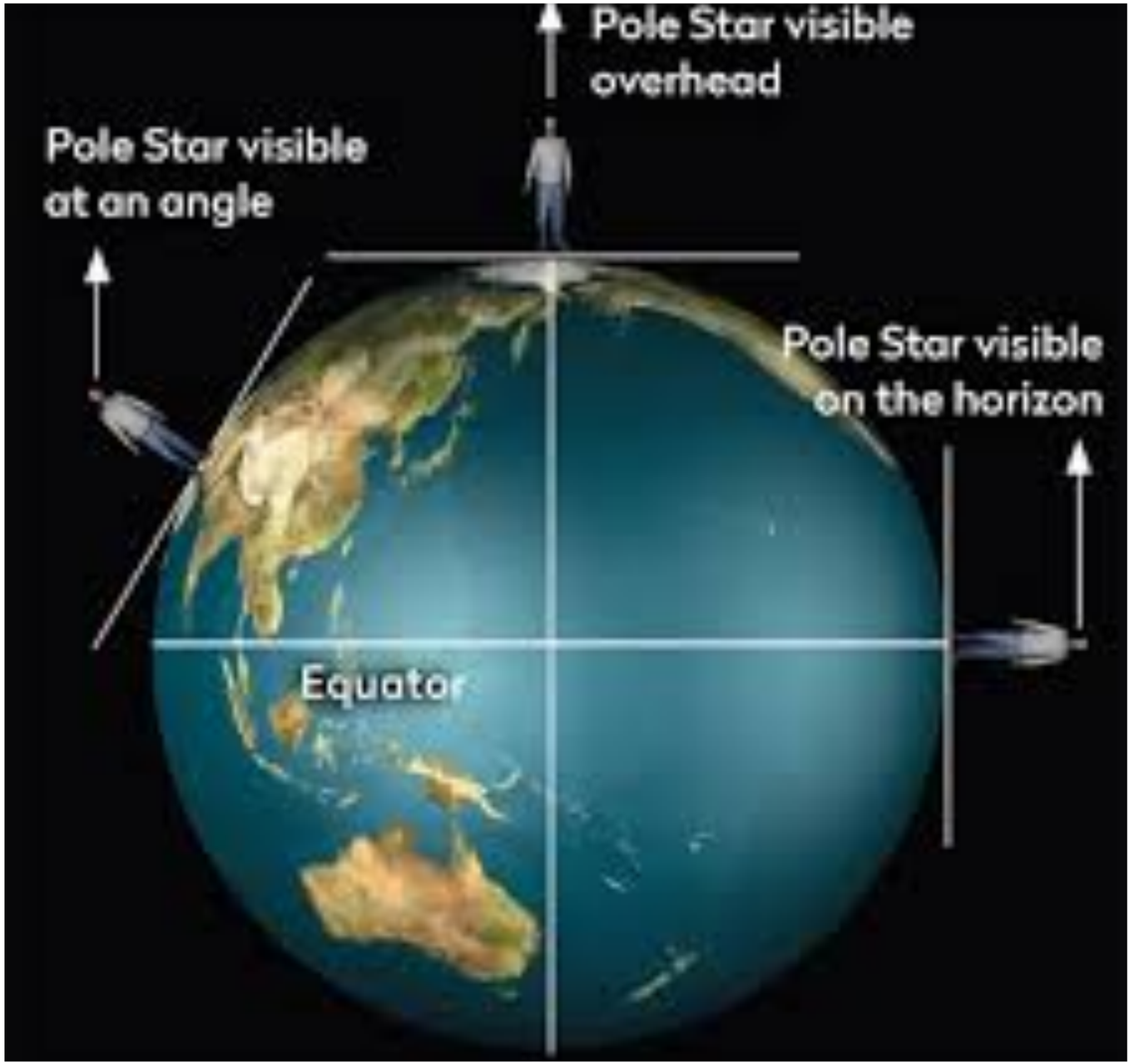
The angle of the North Star, also known as **Polaris,** EQUALS the NORTH Latitude you are at.



A home-made astrolabe

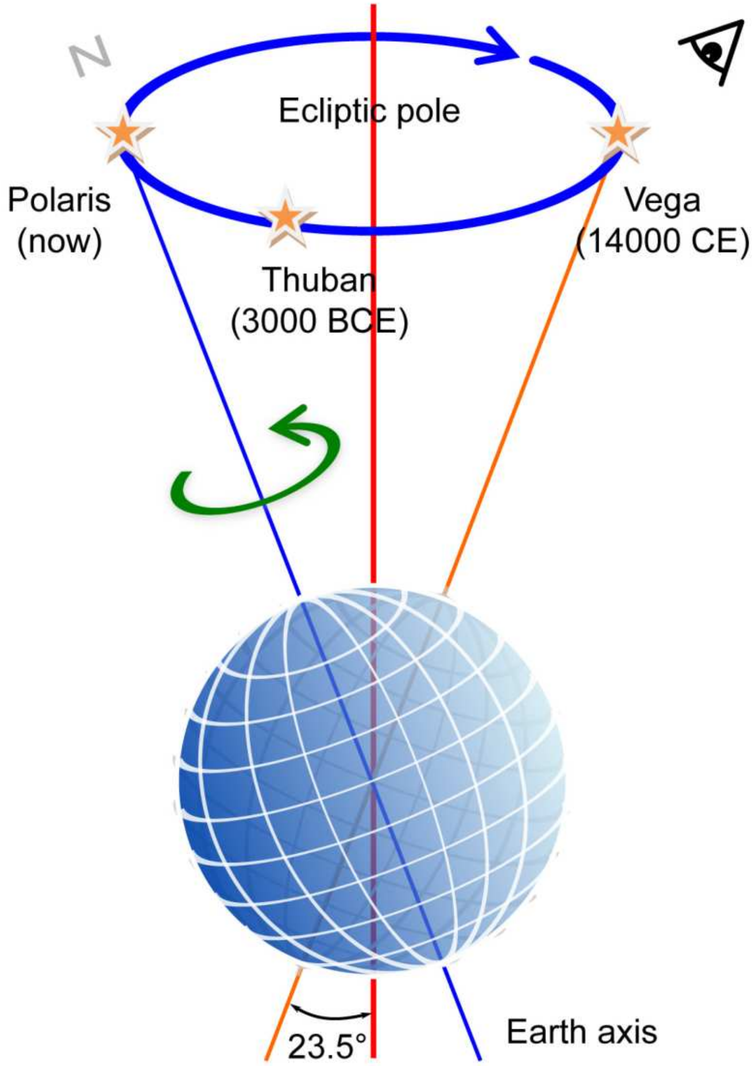


Measuring Your Latitude Using Polaris

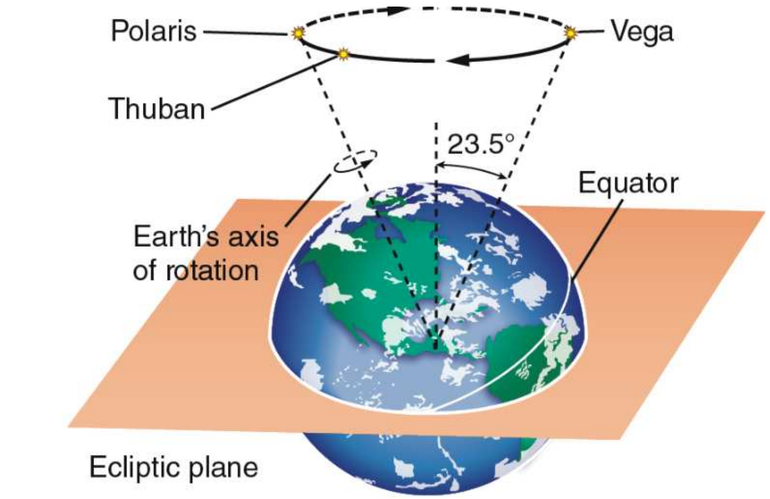


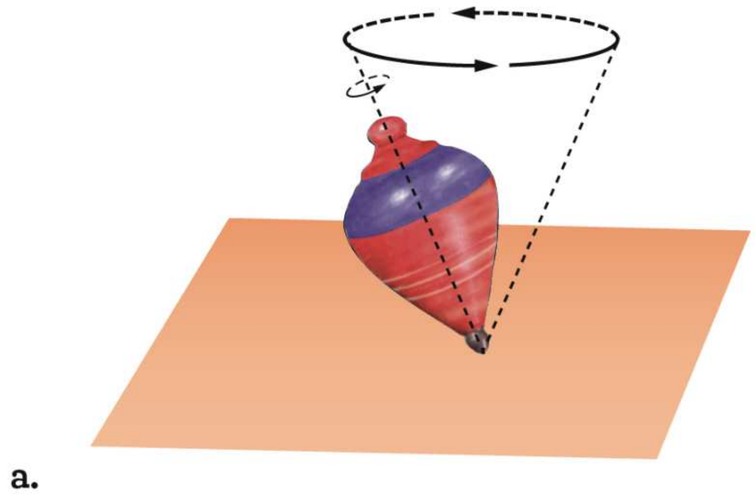
Where Polaris is depends on your latitude !

Polaris was and will not always be our North Star



Earth precesses like a spinning top
every 26 000 years

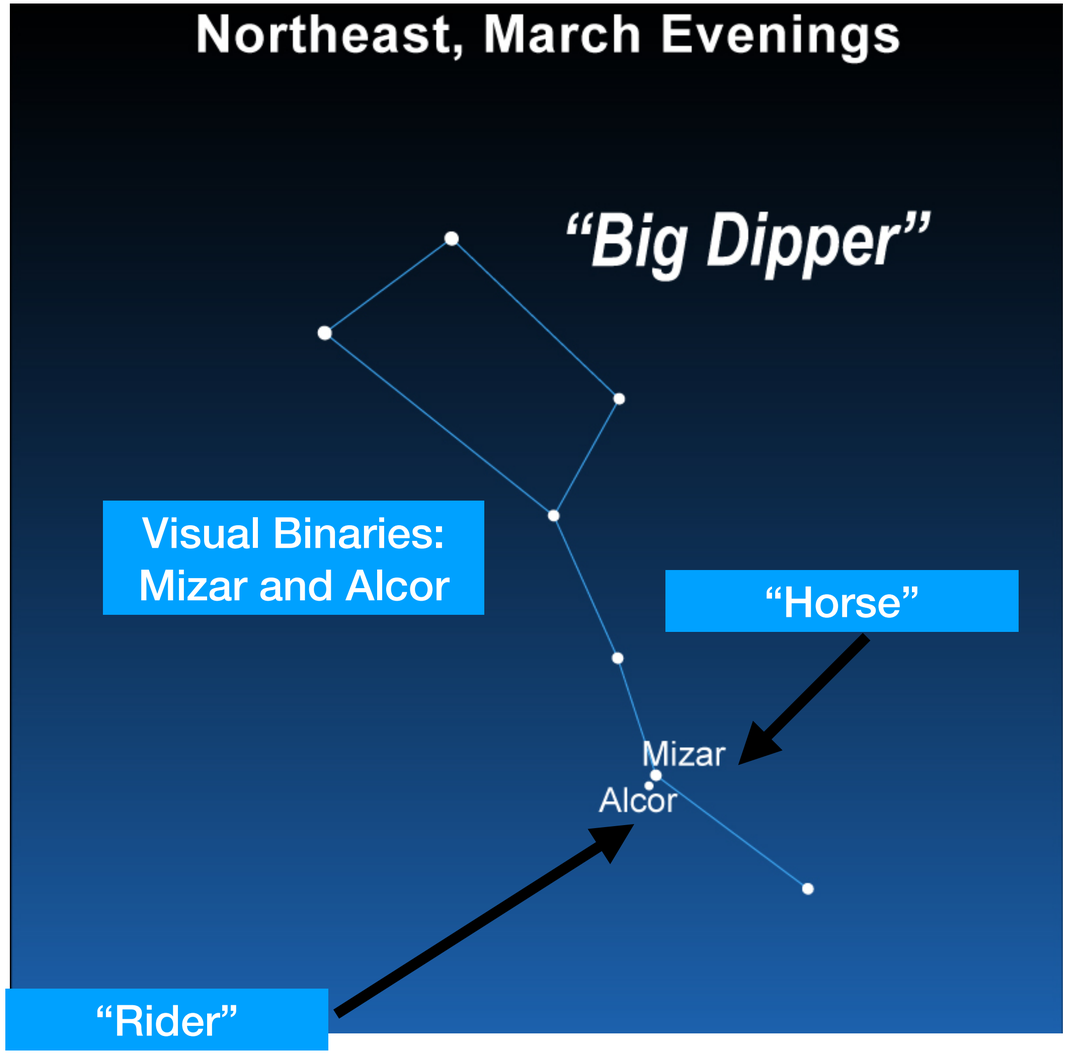




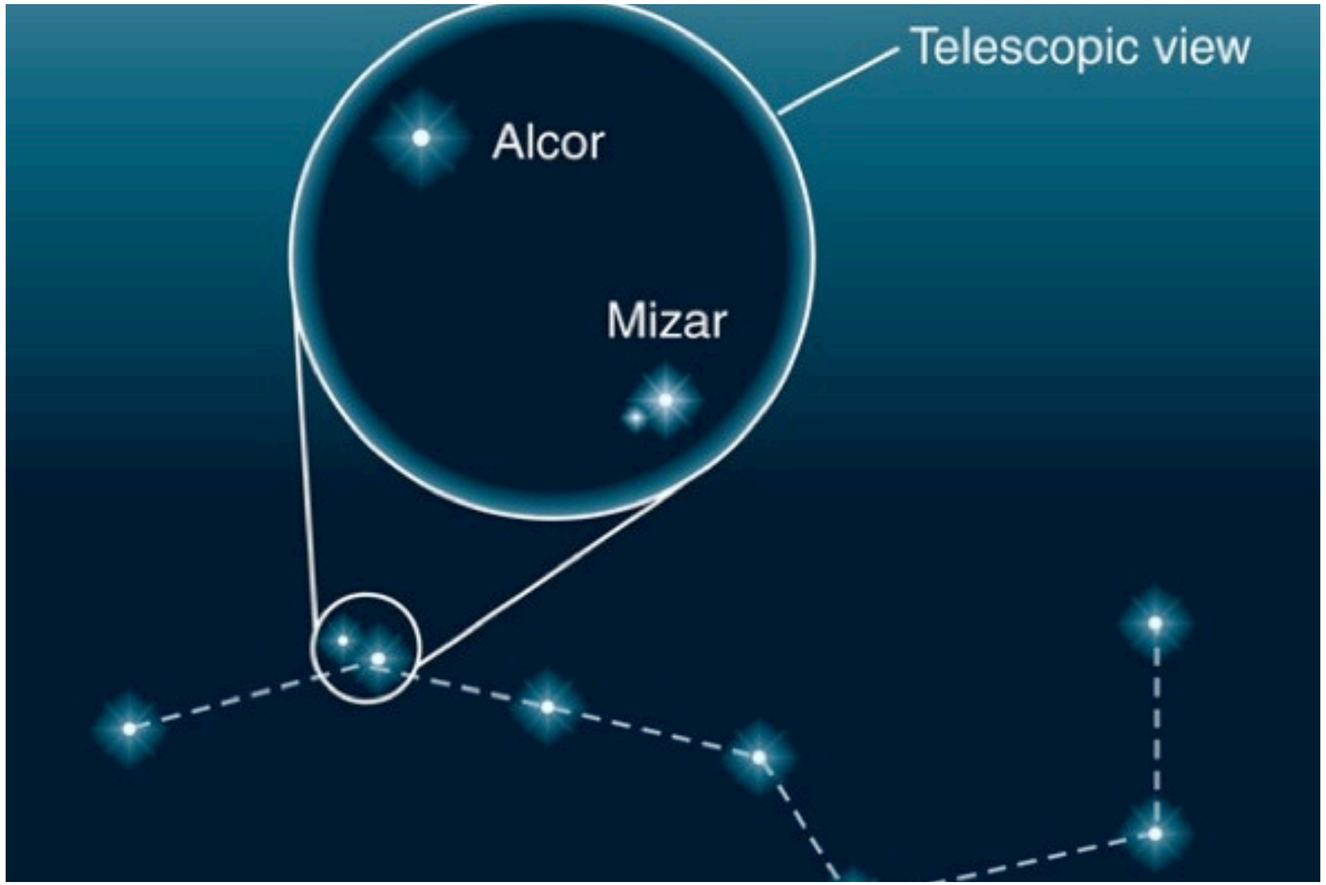
The earth is like a spinning gyro !

Test your eyes:

Can you see both Mizar (bright) and Alcor (less bright) on the Big Dipper's handle?



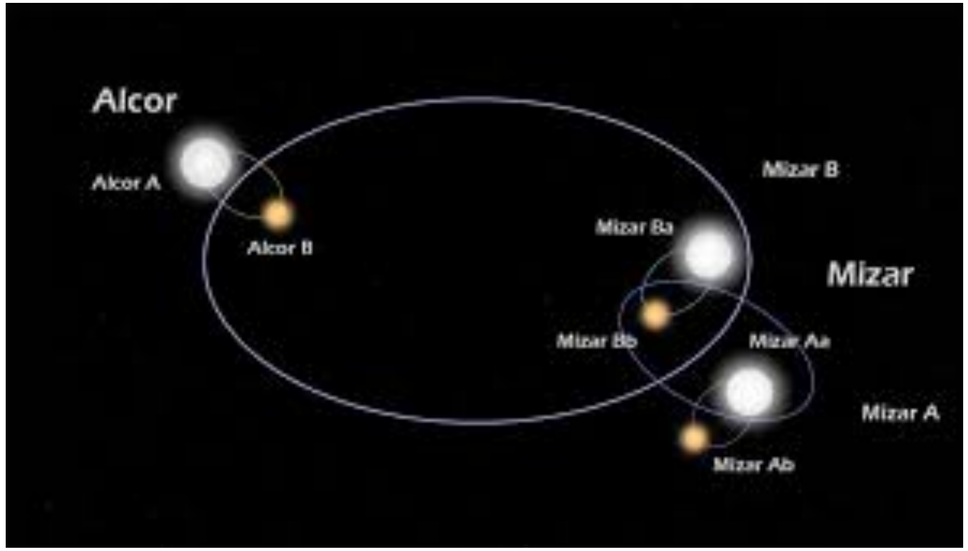
Alcor is the rider and **Mizar** is the horse!



From a small telescope, we know **Mizar A** star orbits a close companion star **Mizar B**. This was discovered in **1617** by Castelli. We now know **Alcor** orbits both of them about a light year away! It looks like this is a three star system, but hold onto your hats! This is actually a **six star system or a sextuplet star system !!**

Alcor-Mizar system is actually a stable, non-chaotic sextuplet system that orbits around each other without breaking apart !

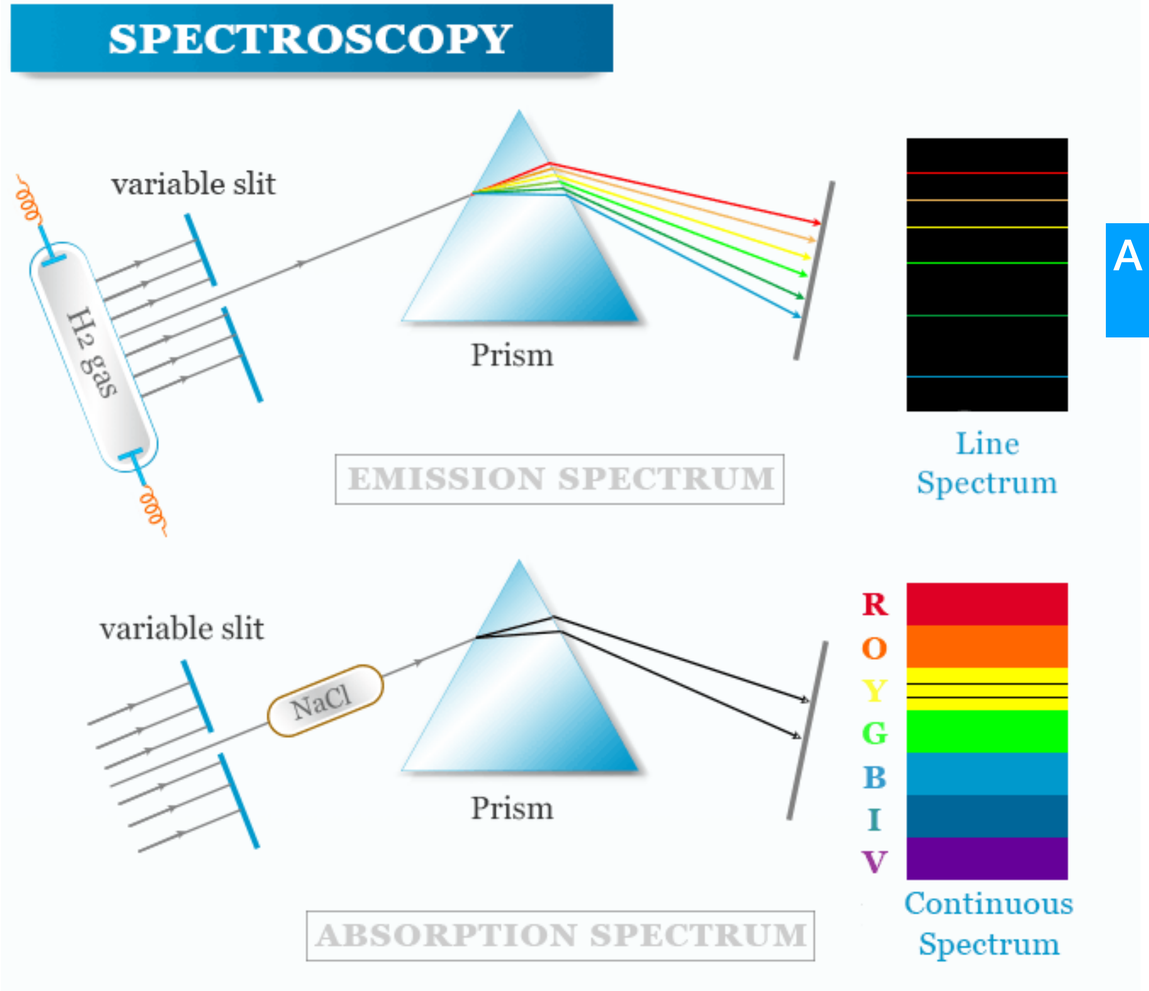
Modern specialized high resolution picture of the sextuplet system



Orbital diagram of Alcor A, Alcor B, Mizar Aa, Ab and Mizar Ba, Bb

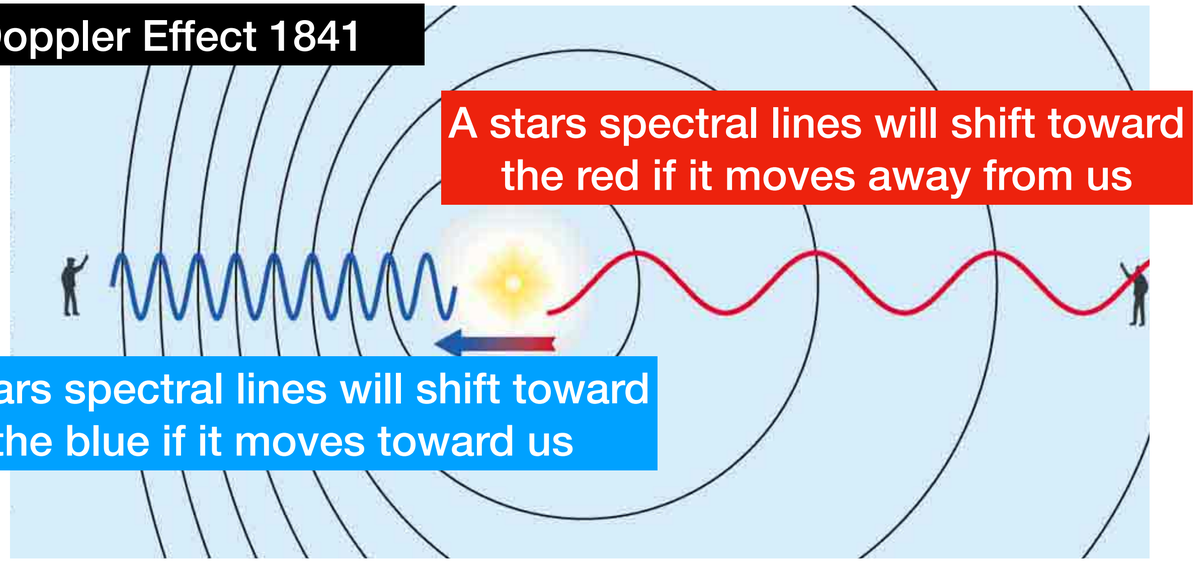
Alcor's little red dwarf companion was discovered recently using a large sophisticated telescope in 2009. **But how were the orbital companions of Mizar A and Mizar B discovered?**

Spectroscopic Binaries

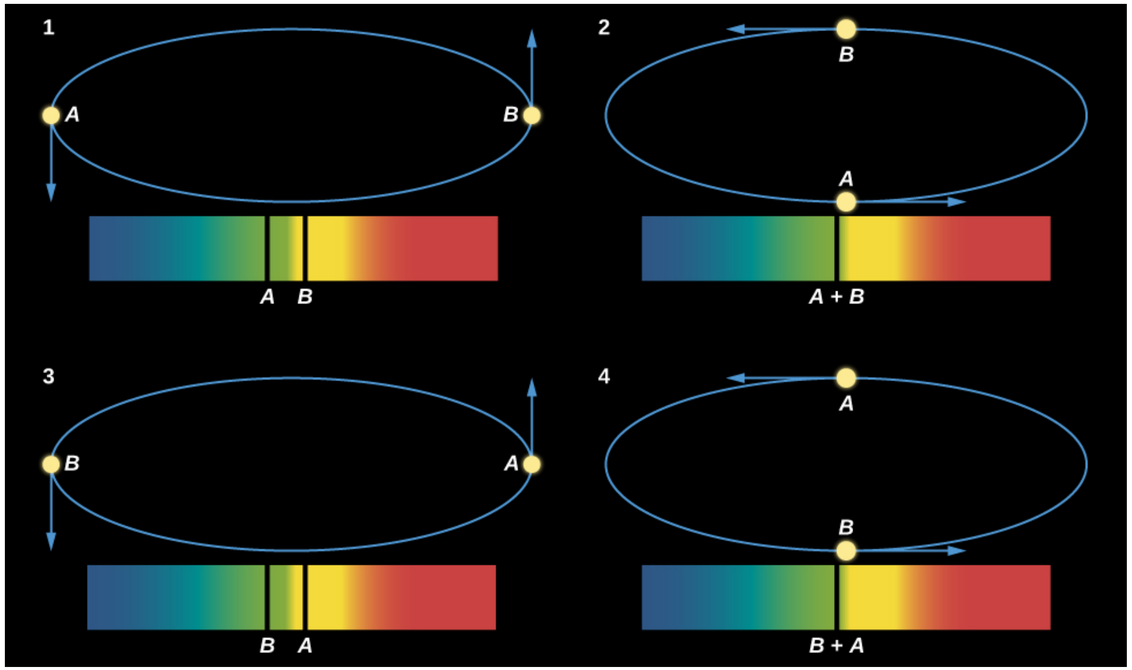


Spectroscope: The cooler outer photosphere of a star leaves **lines or"fingerprints"** on a normal continuous spectrum

Doppler Effect 1841

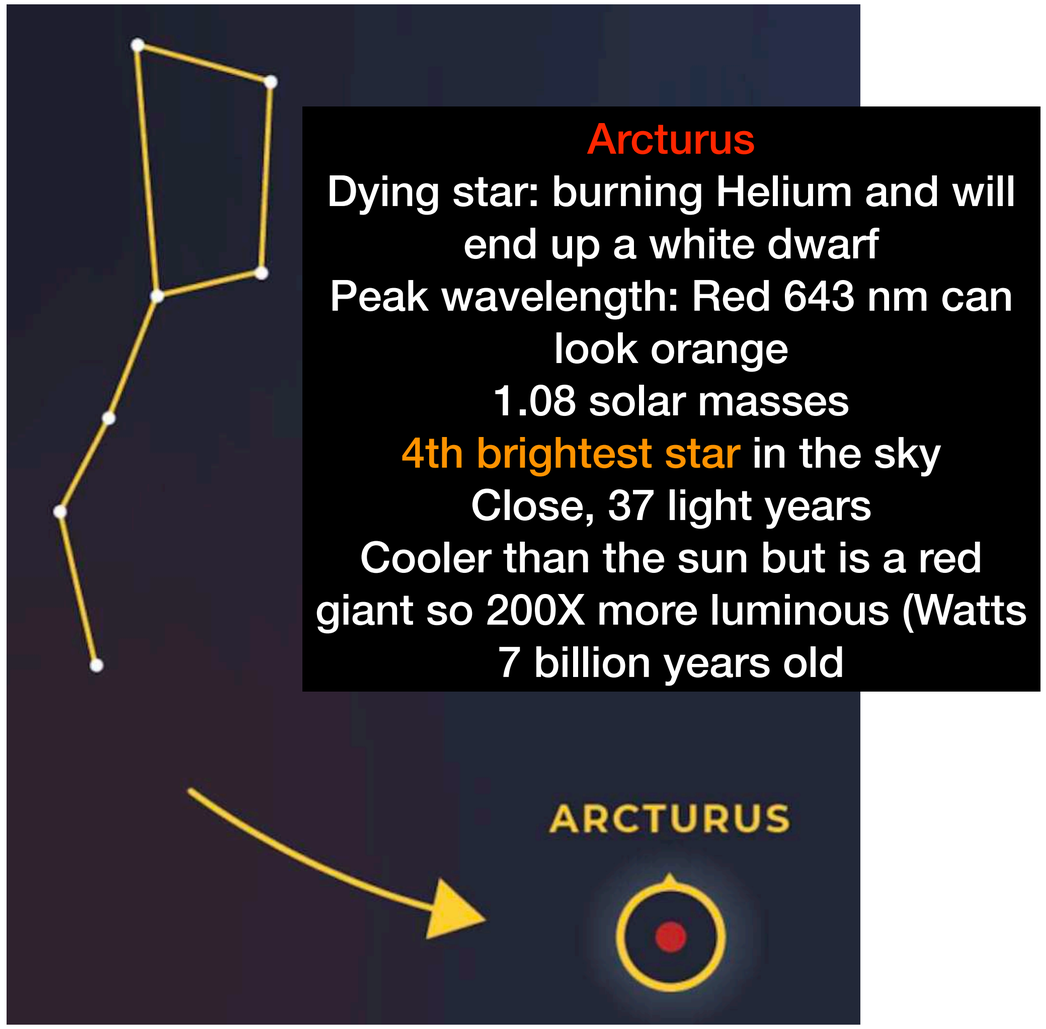


When a star **moves toward** us, its normal wavelength bunches up **shorter** like blue light. When it **moves away**, it stretches **longer** like red-light!

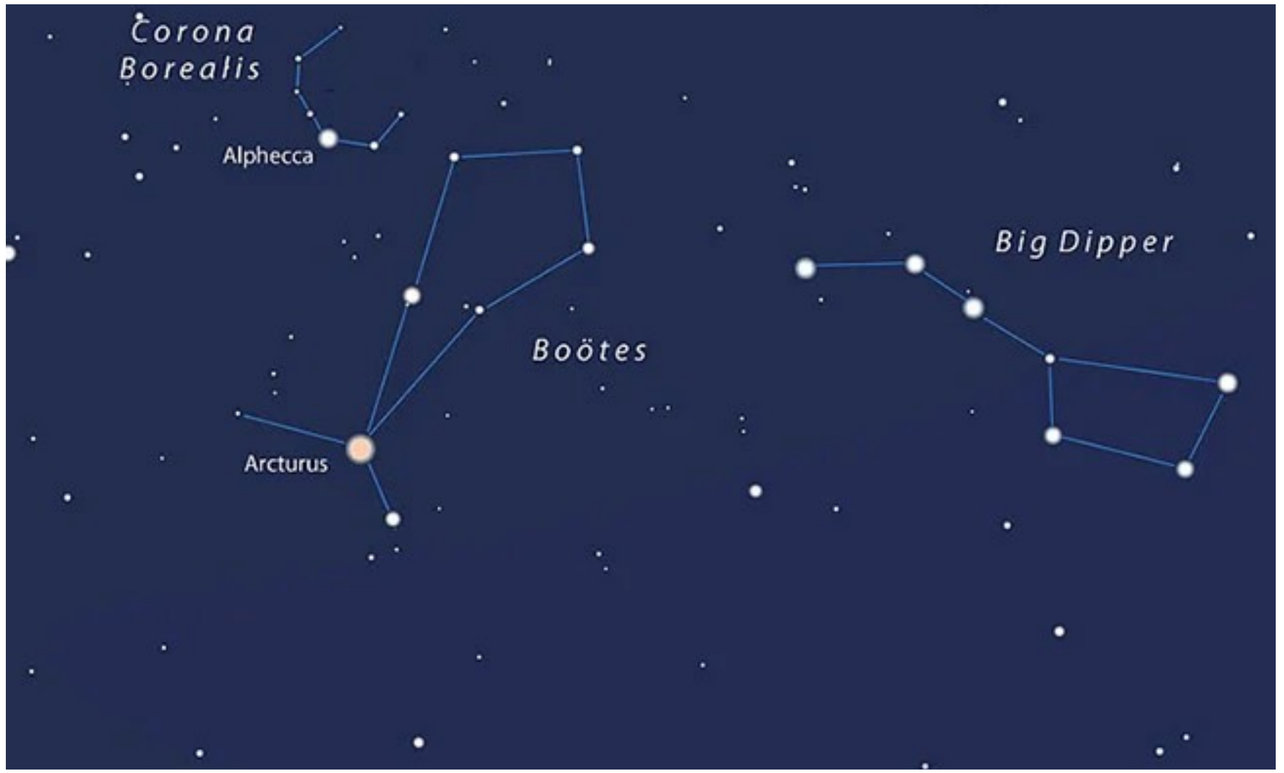


How Mizar Ab and Mizar Bb were discovered

Finding Other Celestial Objects Starting with the Big Dipper

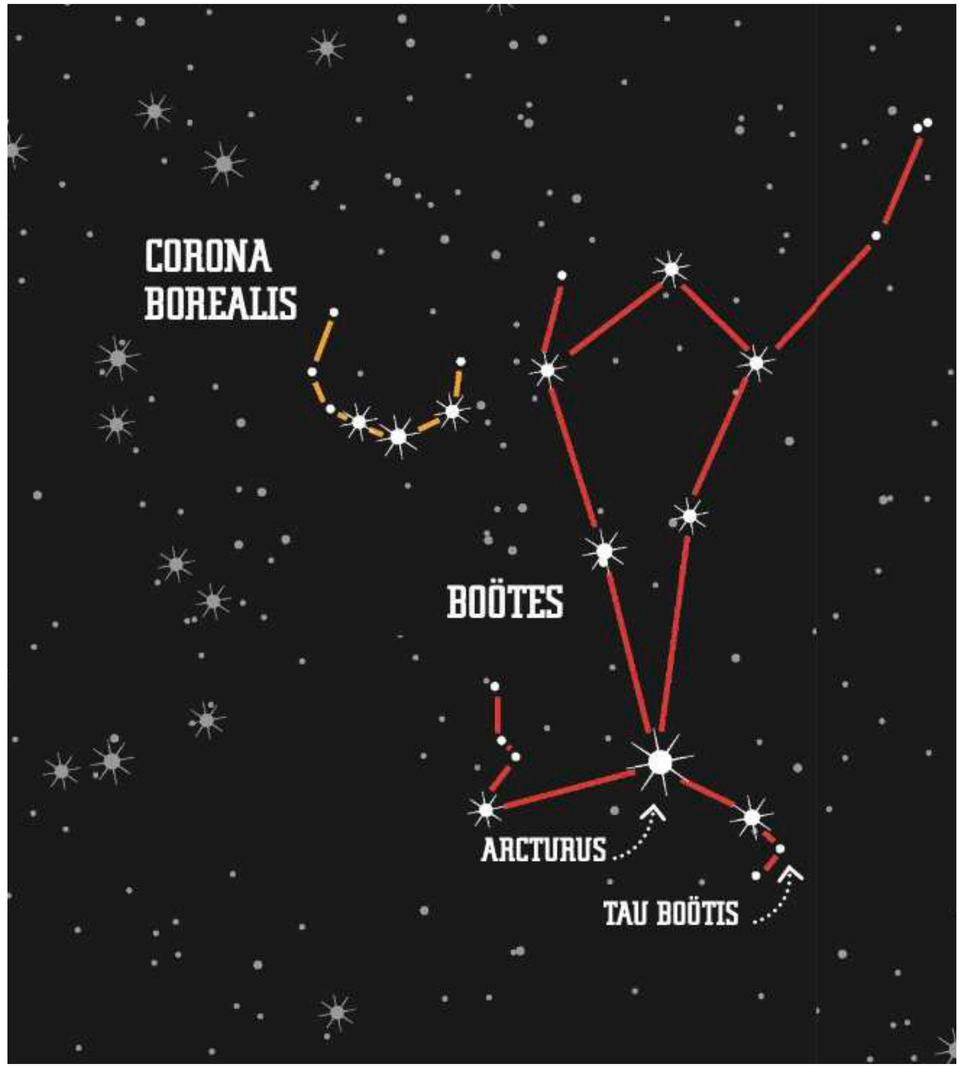


“Arc” to ARCTURUS

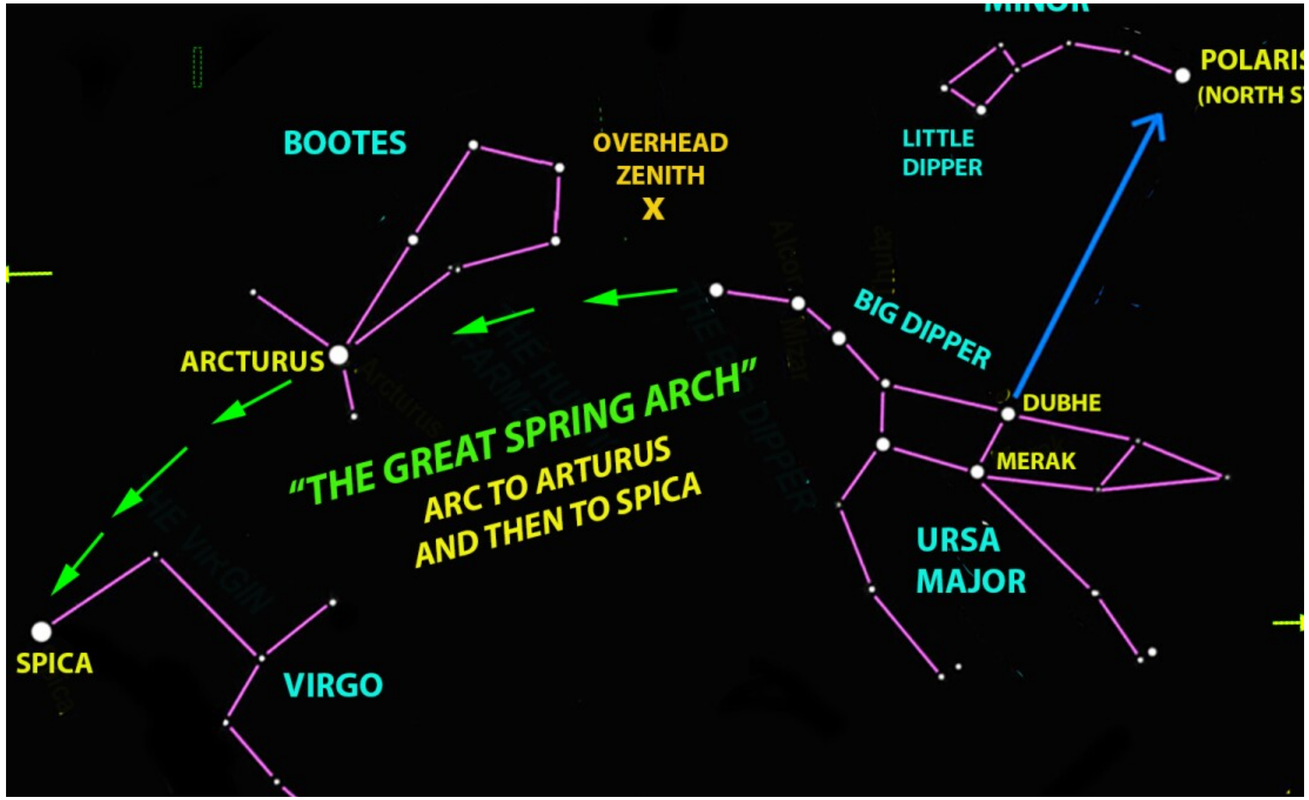


Arcturus is in the constellation of Bootes the Herdsman
Bootes is not circumpolar and does rise and set
Beside Bootes is the 7 stars of Corona Borealis Constellation
(Northern Crown of Ariadne)

Finding Other Celestial Objects Starting with the Big Dipper



Tau Bootis is also a star in Bootes. One of the first planets outside our solar system was discovered here in the 1990's !



Moving along another arc from Arcturus, we can get to **Spica** in the constellation Virgo, seen in the spring

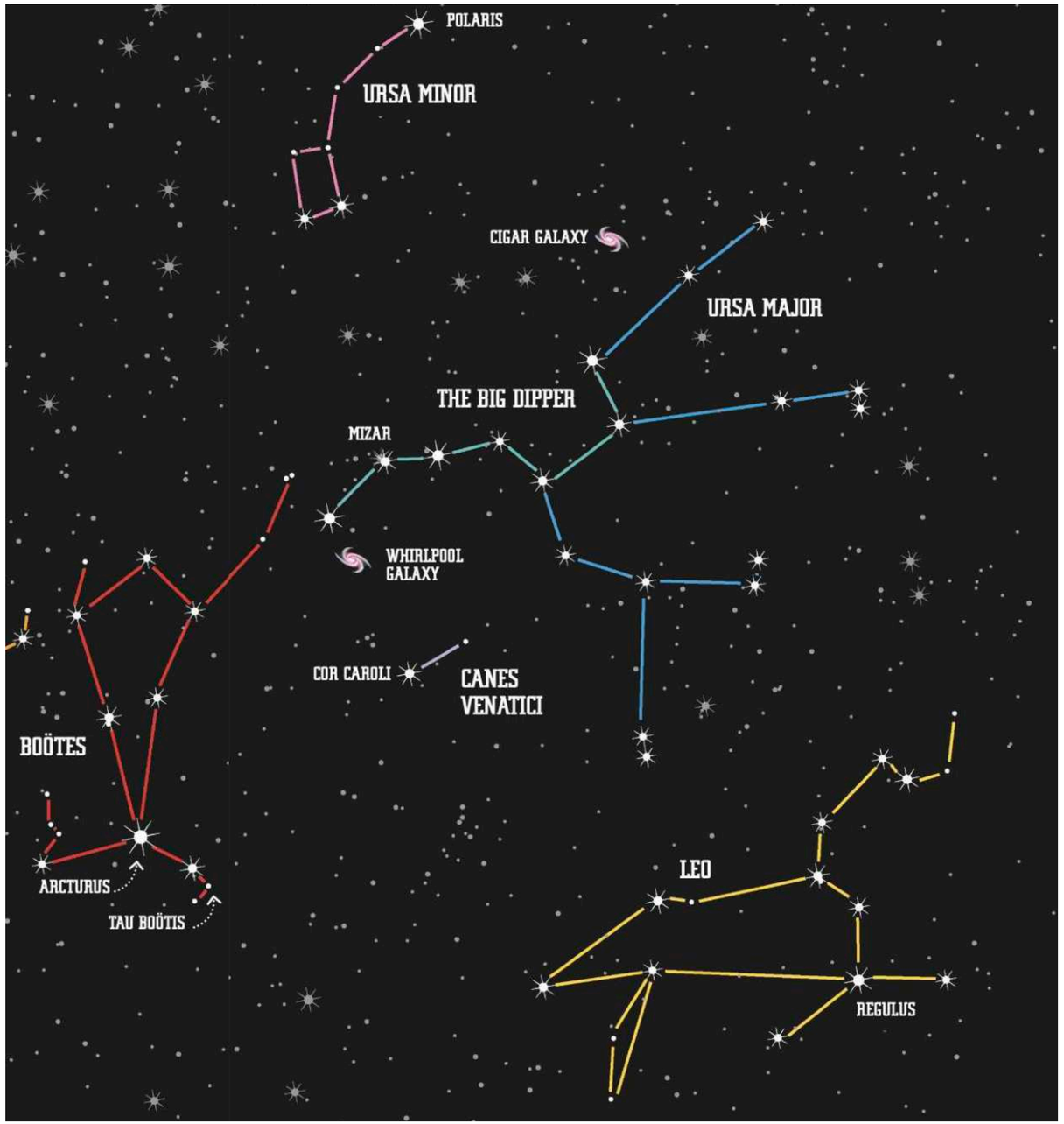
Spica A

Spica A and Spica B / spectroscopic binaries. Spica A is 10 sun masses and is a hot young blue giant.

Peak colour is blue seen as blue-white. It is very hot at 22 000 K (sun is 5800 K). It is a variable star with a cycle 4 days. It is 250 light years away.

It is 15 000 times more luminous than the sun (Watts)

Spica A will end its life in only a few million years as a supernova !

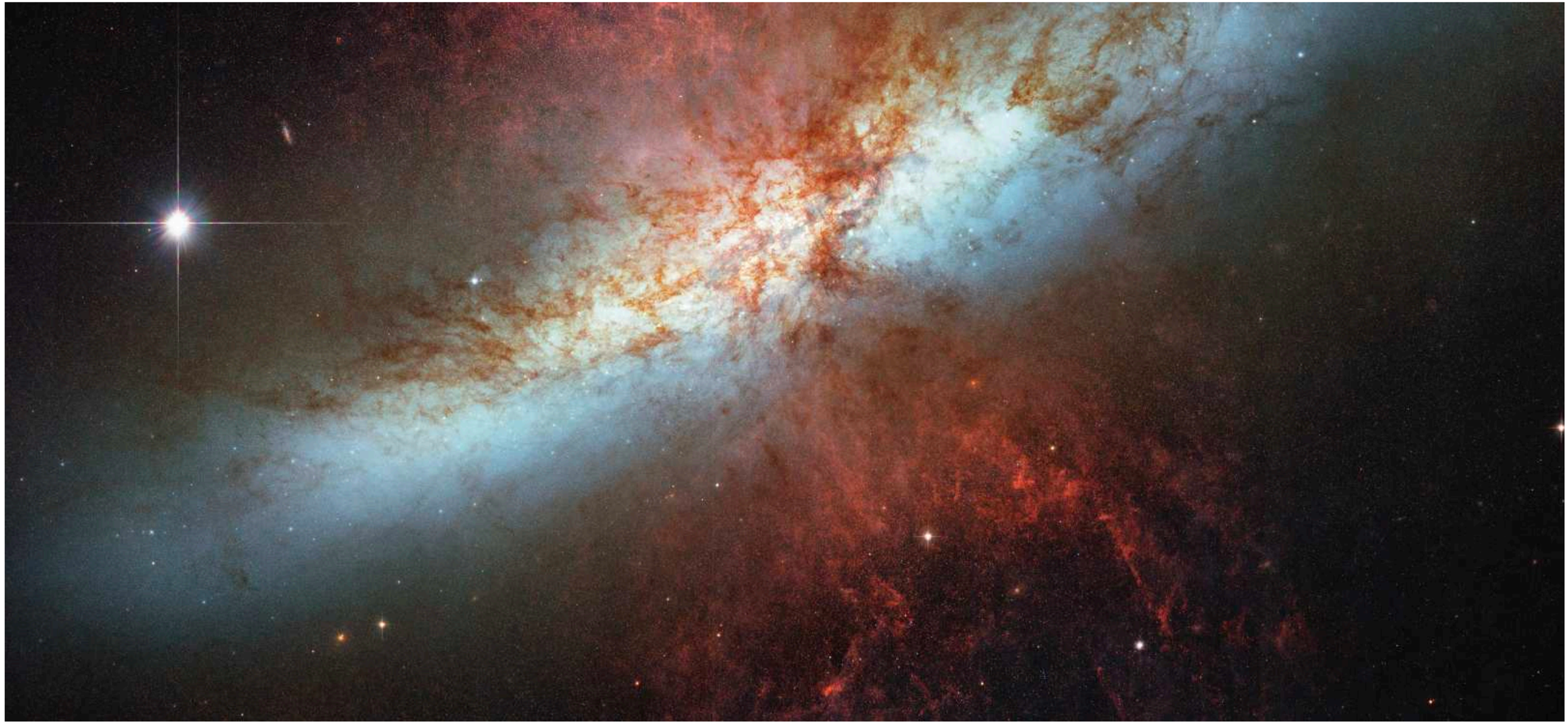


More Spring stars and galaxies are near “The Big Dipper” and Ursa Major Constellation

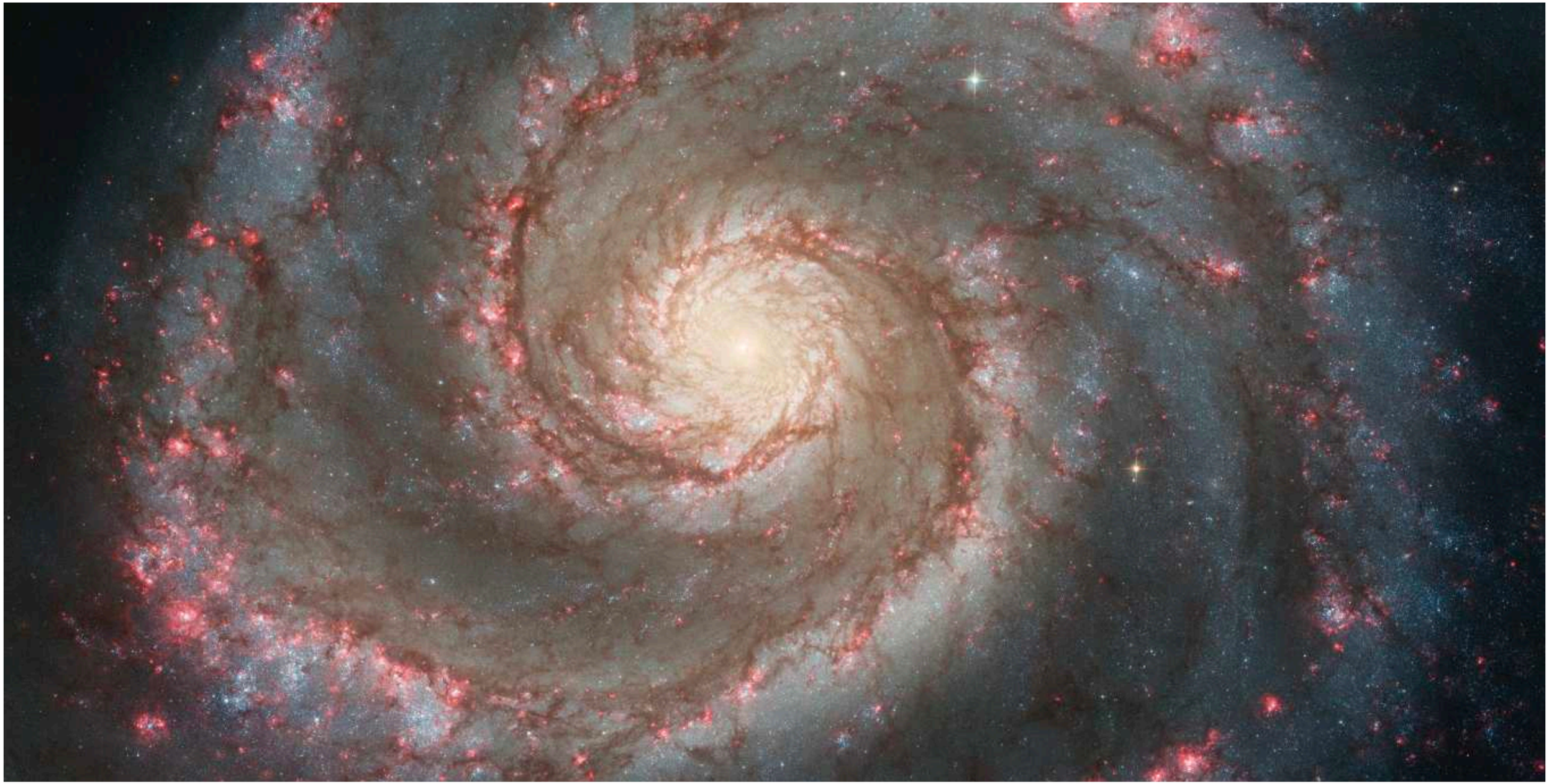
The Cigar Galaxy M82

In 1781, Charles Messier cataloged two fuzzy patches of sky or nebula fixed in the sky **near Ursa Major** as shown. He recorded them as M82 and M81. He was looking for comets so he thought of these “smudges” as bothersome to his pursuit of finding comets! He recorded **100 Messier Objects** or nebula. Many of these objects are galaxies with hundreds of billions of stars. We now know his **M82 nebula or NGC 3034 (New General Catalogue)** is the cigar shaped “star burst” galaxy **12 million light years away** with stars being formed ten times faster than in our own Milky Way Galaxy! Nearby M81 galaxy is colliding with M81 to trigger “star birth”. These galaxies **can be seen with binoculars!**

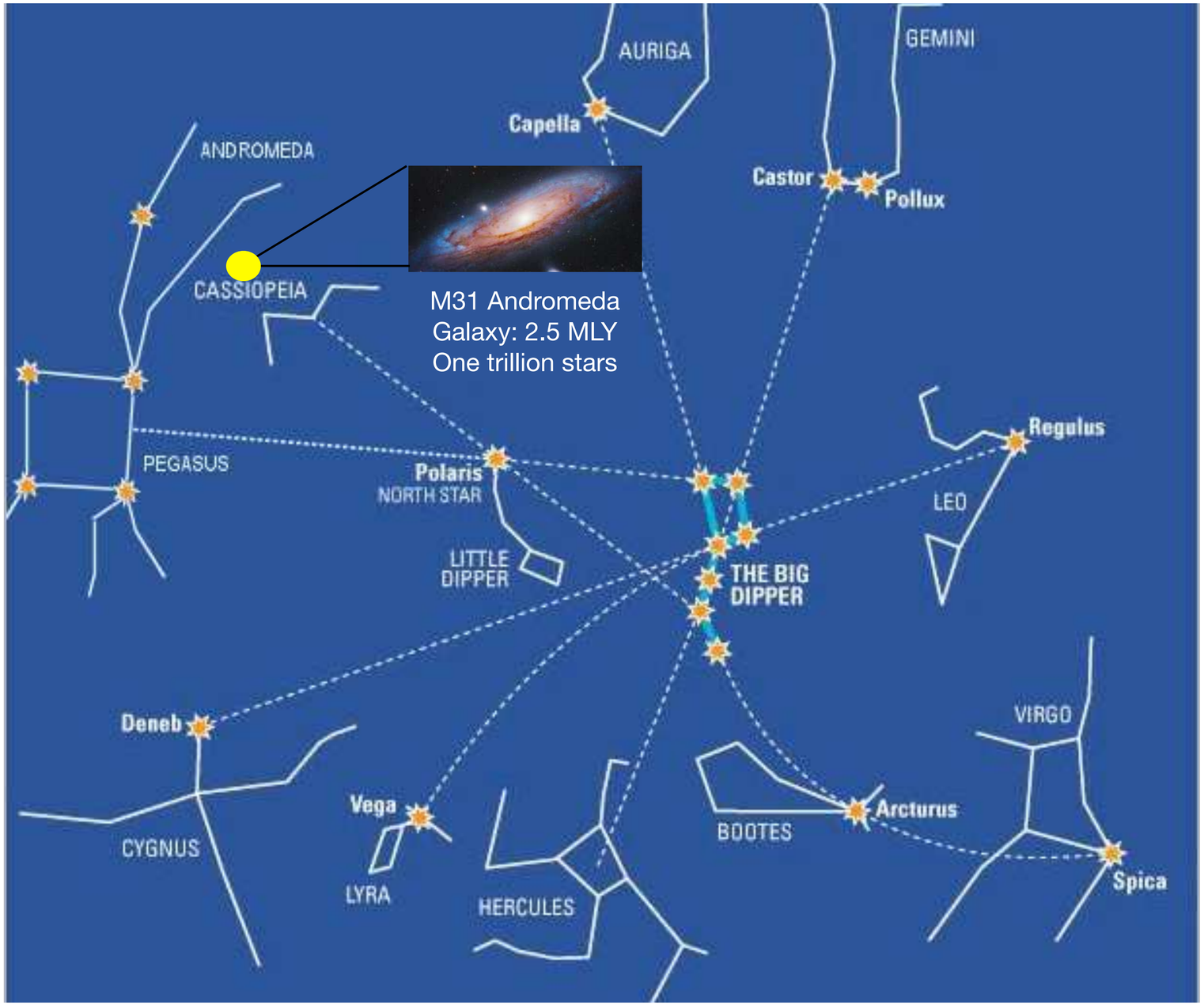
M81 on the left and M82 on the right are colliding galaxies 12 million light years away with much star formation dust clouds of hydrogen. This is a large telescope image taken in visible and infrared light!



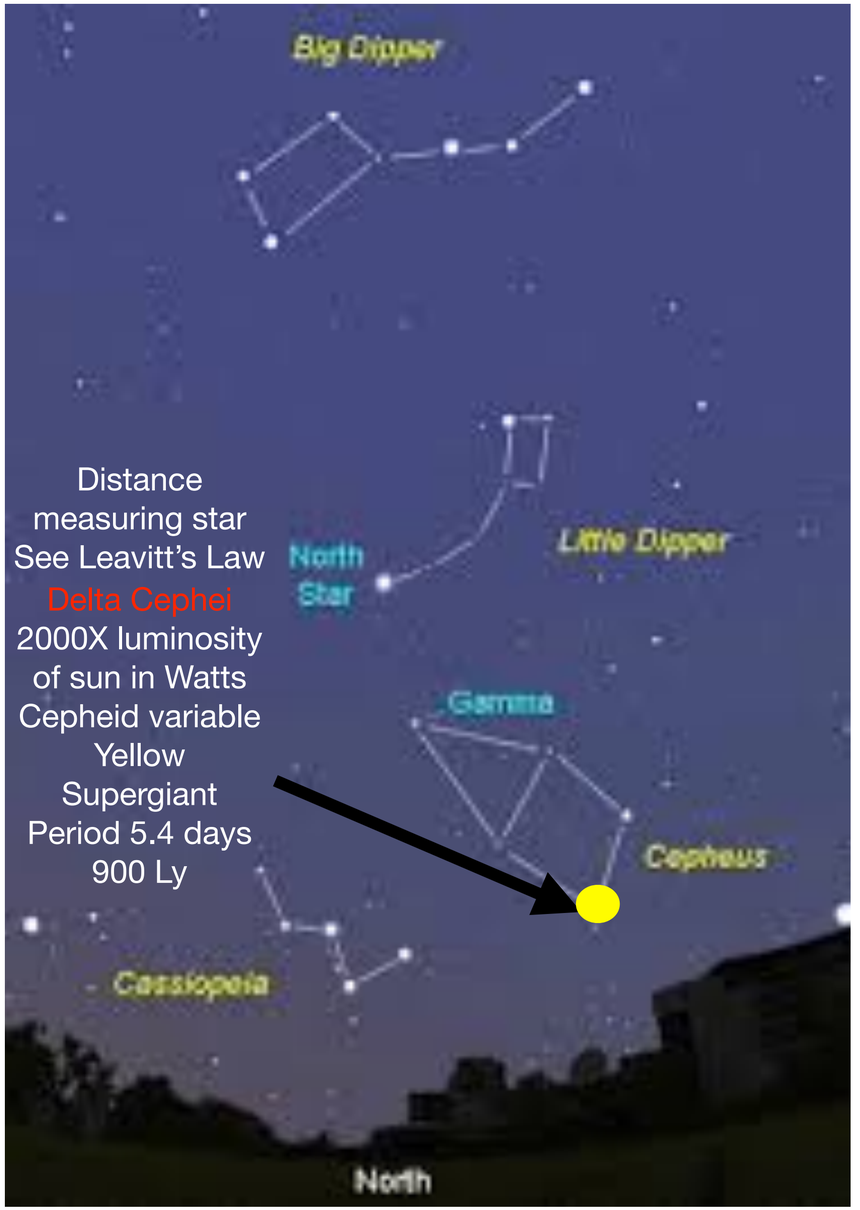
A Hubble Space Telescope HST image of the cigar galaxy M82 or NGC 3034 taken in visible and infrared light.



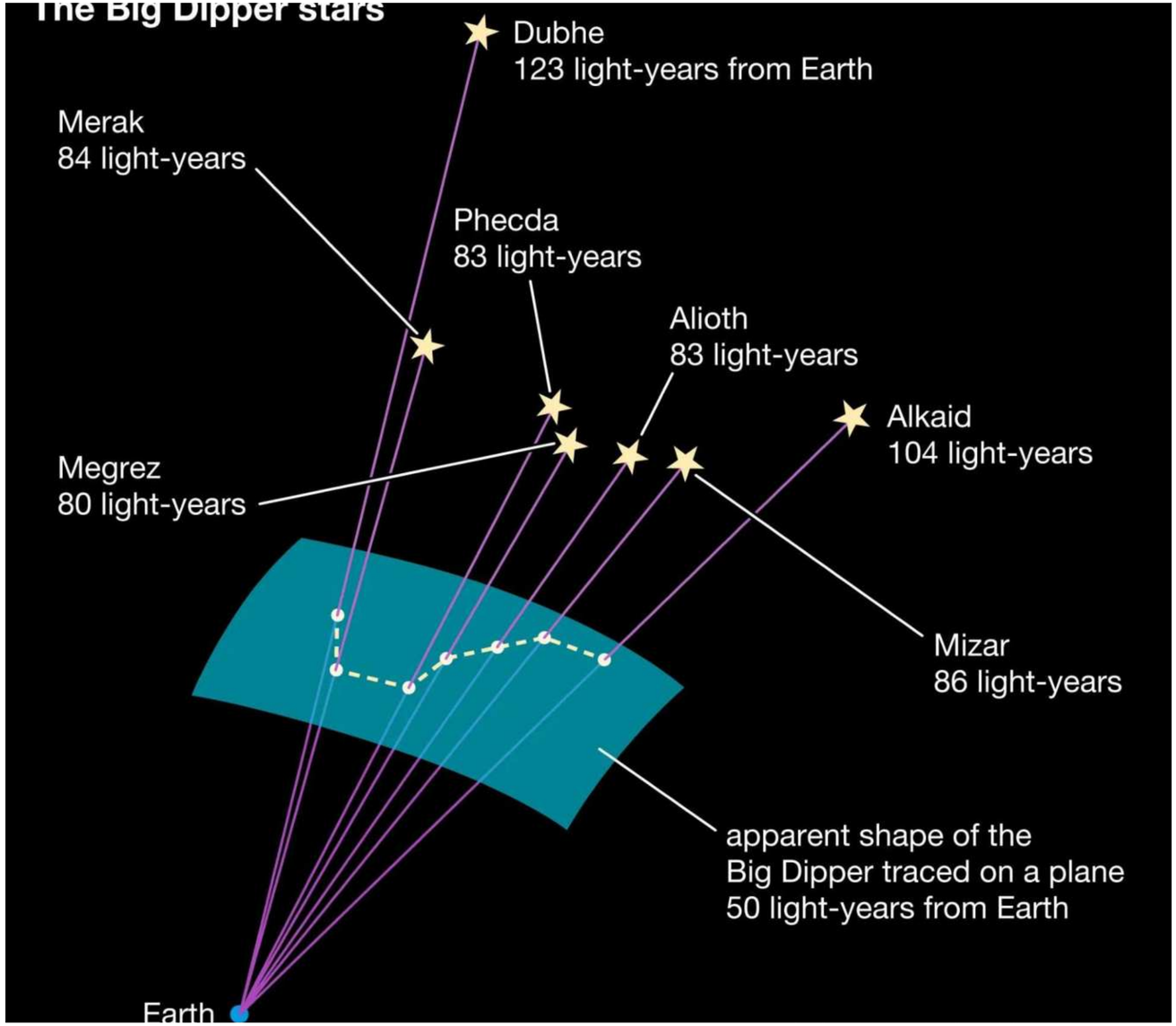
31 MLy away, Whirlpool galaxy NGC 5195 can be seen with binoculars or telescope near the handle of the Big Dipper! This HST image is taken in both visible and infrared light!



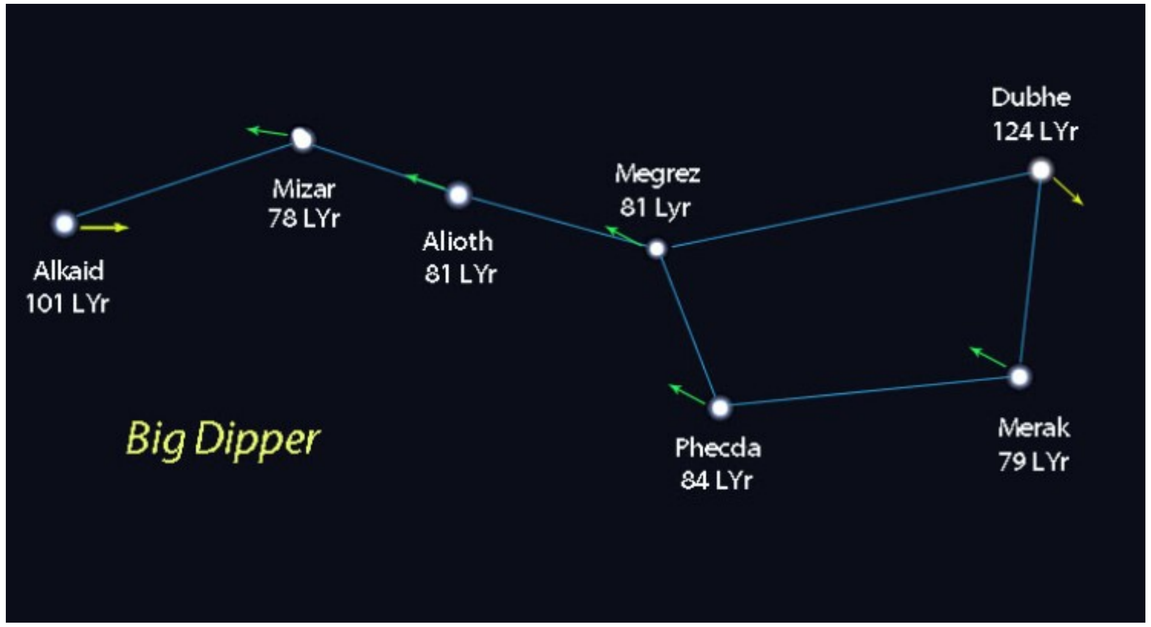
How the Big Dipper is helpful for finding other prominent stars, galaxies & constellations !



This diagram shows how the Big Dipper can help locate other circumpolar constellations !

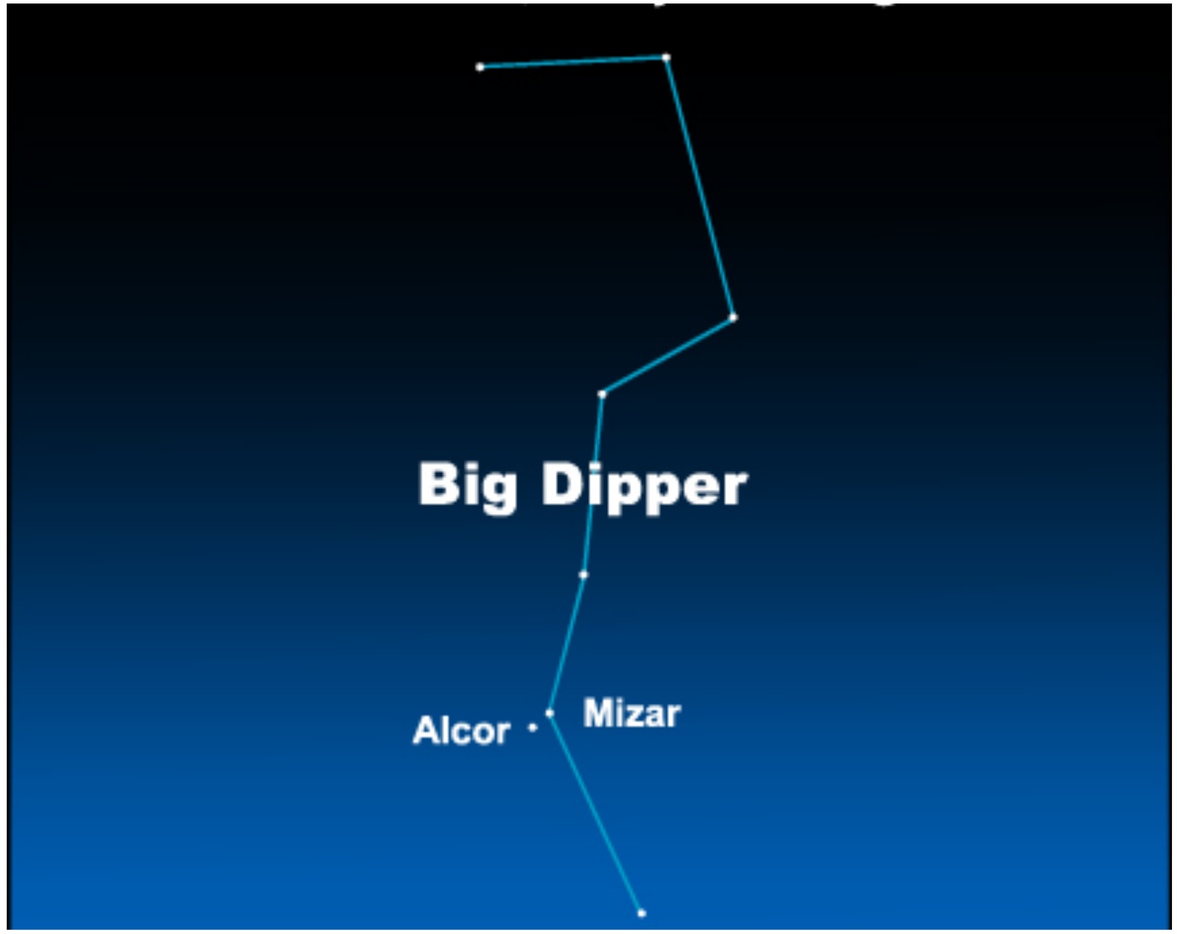


The Big Dipper Stars are **not the same distance away** from earth. These distances are not quite the most recent accurate measurements. For example, **Mizar has been determined to be 81 light-years away** from European Space Agency **Gaia satellite parallax measurements.** (2015-2025)

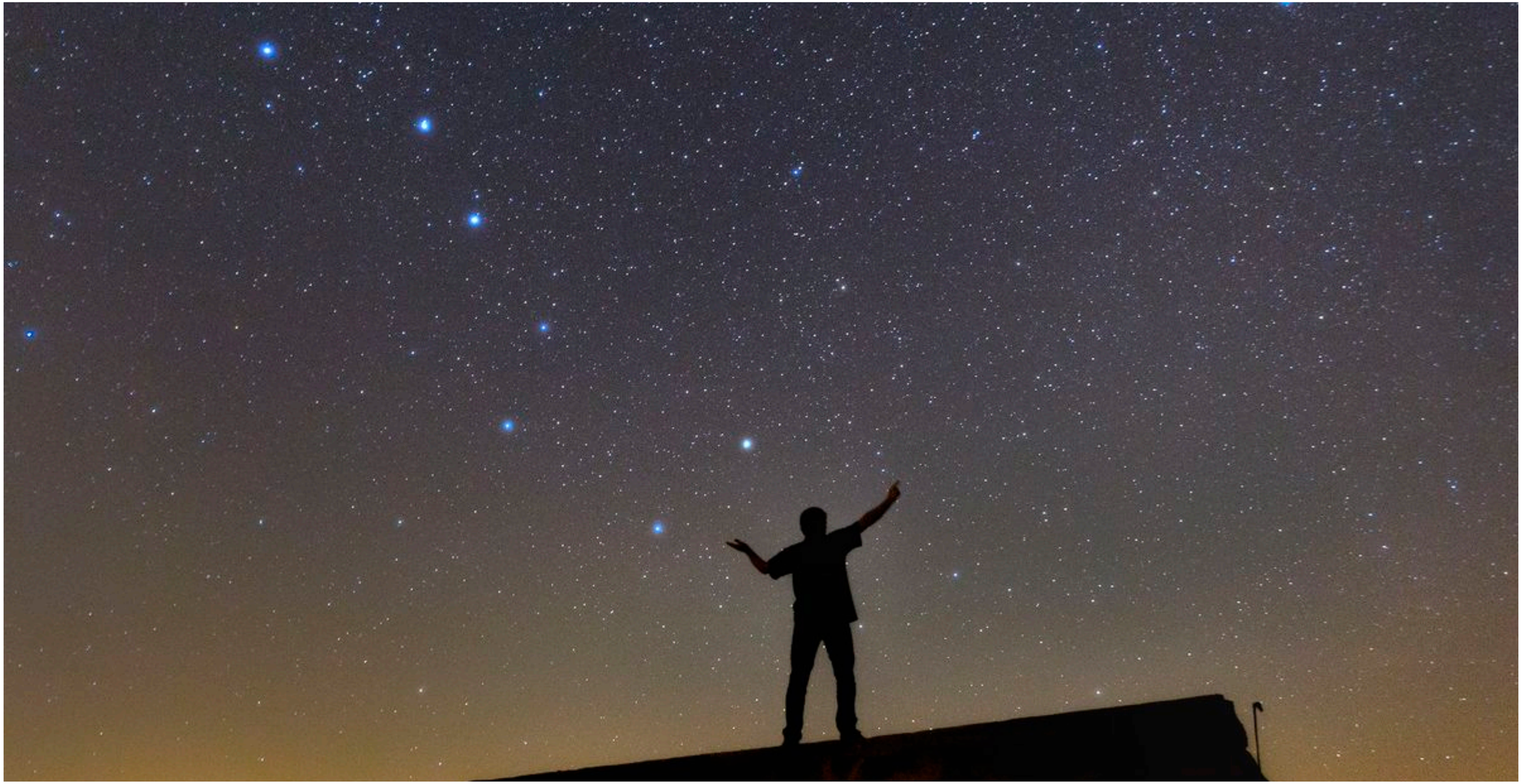


Many of the Big Dipper stars and Ursa Major stars are **near each other and move together** as a group. **Five of the bright seven** Big Dipper Stars, Mizar, Alioth, Megrez, Phecda and Merak are all neighbours and are about 80 light-years away and move in the same direction. This group of five are part of the **Ursa Major Moving Group.** They share a common origin born about 400 million years ago. As you can see from both diagrams, Alkaid and Dubhe are not part of this group.

The Big Dipper in Spring



Another picture of The Big Dipper to the Northeast in early spring



A roof top “Hello” to the Big Dipper ! Make sure you have a good look at it !

The end or maybe a **new beginning** !