The Night Sky

by Ken Graun

Overview

The stars, planets, Moon and Sun "reside" on what is called the **Celestial Sphere** where the stars appear to be "fixed," similar to how the land and islands are fixed on the Earth. However, these celestial objects do "move" across the sky *daily* because of the Earth's rotation. Now, the stars *are* moving through space but they are so far away that it takes thousands of years to notice any movement.

And, because the Earth revolves around the Sun, we see a different set of stars at different times of the year—the night side of Earth points in different directions throughout a year.

Since our Moon and planets are "closeby," (at least compared to the stars) and have orbits, they move through our set of fixed stars, the Moon fast and the planets slower.

Polaris, the North Star

It is a physics thing that the Earth's axis always points to the same spot on the celestial sphere (stable like a fast spinning top) as it orbits the Sun. In the northern hemisphere, it points very close to the bright star Polaris, known as the North Star. There is **no bright South Star** in the Southern hemisphere. We who live in the Northen Hemisphere are lucky to have a very visible North Star.

Since the Earth's axis always points to Polaris, it gives the appearance that all the other stars revolve/circle around it. So, in the northern hemisphere, when you face north at night, the one star that doesn't move is Polaris and because of this, it could be used for navigation at night but most people use their phones.

Ecliptic, the Sun's path & zodiac

If you could see the stars during the day, you would notice that the Sun slowly moves through a set of 12 constellations over a years time—completing a circle. Obviously, this is a "perspective thing" that occurs as the Earth orbits the Sun. This path or circle that passes through these 12 constellations is called the **Ecliptic** and the area or band above and below the ecliptic that contains those 12 constellations is called the **Zodiac**.

Now, all of the planets in our solar system, including our Moon, orbit in the same plane or very close to the same plane around the Sun. Therefore, our Moon and our eight planets will always be found close to the ecliptic—definitely within the band of the zodiac. And, the Moon and our planets move slowly eastward on the ecliptic because they, like the Earth, move counterclockwise in their orbits about the Sun.

Magnitude. . .Measuring brightness

The brightness of objects in the sky is based on a Magnitude scale that begins with the Sun at –27 and fades to stars fainter than +35. The visible stars to the naked eye vary from –1.4 for Sirius to around +6. The visible planets vary in brightness depending on how close they are to Earth. Here is a short list of objects by magnitude visible to the naked eyes.

Object	Magnitude
Sun	–26.73
Moon	–12.6 at Full Moon
Venus[1]	–4.9 at its brightest
Mars[1]	–2.94 at its brightest
Jupiter[1]	–2.94 at its brightest
Saturn[1]	–0.55 at its brightest
Sirius	–1.46
Arcturus	–0.05
Capella	+0.08
Betelgeuse	+0.58
Polaris	+2.01

[1]The magnitude of these planets vary and depends on their distance to Earth. The faintest they fade to is –2.98 for Venus, +1.86 for Mars, –1.66 for Jupiter and +1.17 for Saturn.

Naked-eye star count

About 5,000 stars to about magnitude +6 can be seen with the naked eyes under really dark skies, which includes both hemispheres. The count of stars by magnitude is below.

Mag.	Count
–1	2
0	6
+1	14
+2	71
+3	190
+4	610

Mag.	Count
+5	1,929
+6	5,946
+7	17,765
+8	51,094
+9	140,062
+10	368,275

Constellations

There are 88 constellations in the sky, each defined by a boundary, just like states. The smallest constellation is Crux, visible from the southern hemisphere and the largest is Hydra which also stretches the farthest across the Celestial Sphere. And, Serpens is the only constellation to be discontinuous—made of two parts, on both east and west sides of Ophiuchus. Most of the Northern Hemisphere constellations were named by the ancient Greeks with a few smaller ones added around 1600.

Asterisms are a "recognizable" and/or "interesting' pattern of stars that can be part of a constellation and either naked-eye or visible only in a telescope or binoculars. The Big Dipper is technically an asterism as well as Leo's Sickle or backwards question mark. There is the Coathanger asterism in Vulpecula (near Cygnus) that can be seen in binoculars and it does resemble a coathanger!

Comparing the real brightness of stars—when next to each other

The brightness of stars in the sky is determined by a mixture of their actual brightness *and* distance. Obviously, the farther a star is away, the fainter it will appear.

Absolute Magnitude is a star's magnitude if placed at a distance of 10 parsecs which is 32.6 light years from us (see back for definition of light year). So, absolute magnitude provides a standard to compare the actual brightness of all stars if they were all next to each other. At this distance, the following stars would have a magnitude of:

Star (Magnitude)	**Absolute Mag.**
Sun (–27)	+4.8
Polaris (+2.01)	–3.6
Sirius (–1.46)	+1.4
Arcturus (–0.05)	–0.30
Betelgeuse (+0.58)	–5.0
Vega (0.0)	+0.6
Spica (+1.0)	–3.6

Star Names — mostly Arabic

Although most of the northern constellations were created and named by the ancient Greeks, the names of many stars are from Arabic, especially the ones that start with the letter A (except for Arcturus). So, Betelgeuse, Vega, Deneb, Rigel, and Spica as well as 200 other star names are Arabic.

What is the Milky Way Galaxy & Milky Way Band?

All stars reside in giant groups of stars called galaxies. There are billion of galaxies in the universe, each containing multi-millions to billions of stars. Our Sun, a star, resides in the Milky Way Galaxy, named from the Milky Way Band. The Milky Way Band represent the bulk of the billions of stars in our galaxy that we see from Earth but are too far and thus too faint to see individually.

You need fairly dark skies to see the Milky Way Band. It is not visible from any major city. In suitable dark skies, it looks like a faint, irregularly shaped band in the sky—it has a good width. It is shaped like a band because our galaxy's shape is like a dish. The thickest and brightest part is between Sagittarius and Scorpius, visible during the summer months, which is the direction to the center of our galaxy.

The Zenith is the highest point in the sky, directly over your head.

The Celestial Meridian is a due north-south "line" that divides the sky in half, into eastern and western halves.

Star Designations & Latin Genitive

Stars can be designated with a name and/or lowercase Greek letter and/or a number and/or a specific catalogue designation. Bayer in the 1600s assigned Greek letters to the prominent Northern Hemisphere stars within each constellation. Usually, the brightest star in each constellation is designated alpha (α). Then, Flamsteed and Lalande in the 1700s numbered the stars in each constellation, more thoroughly than Bayer's letters. The numbers were assigned in order of increasing Right Ascension within each constellation. There are special catalogues assigning designations to almost all stars.

Every constellation has a **Latin Genitive** form which is a spelling that indicates possession. For example, the Latin genitive for Orion is Orionis (there are tables for the genitives). Stars are often identified with either the Bayer letter or Flamsteed number followed by its genitive. Examples: α Centauri, 61 Cygni. Betelgeuse is the brightest star in Orion. It has a Bayer designation of α and the Flamsteed number of 58, so it could be identified as α Orionis, 58 Orionis or just by its name Betelgeuse. Because Betelgeuse has a name, it would be infrequent for it to be identified with its Bayer or Flamsteed number.

Most southern hemispheres stars lack Bayer and Flamsteed designations.

Distance is measured in Light Years

The light year is a measure of *length* and not time. And, that "year" has to do with the distance light travels in one year's time which is a length of nearly 6 trillion miles (5,880,000,000,000 miles). Light travels at the speed of 186,282 miles every second so it can go around the world almost 8 times in a second. It takes light about 8.5 minutes to travel from the Sun to the Earth. The closest star visible to the naked eye is Alpha (α) Centauri which is about 4.4 light years away and it is only visible from the Southern Hemisphere. Our galaxy, which includes all the stars that we see in the night sky is about 100,000 light years in diameter.

Celestial Coordinates, RA & Dec

Any place/spot on Earth can be designated with latitude and longitude coordinates. The same is true for celestial objects but the coordinates are called Right Ascension and Declination. Declination is similar to latitude. It starts at the celestial equator (a projection of the Earth's equator onto the celestial sphere), which is 0° and ends at +90° for the North Celestial Pole and –90° for the South Celestial Pole. Right Ascension is like longitude but it uses the 24 hours of time as its divisions. And, the 0 hour starts where the Sun is at the Vernal Equinox (beginning of Spring—Sun is in Pisces) and progresses eastward in 1 hour increments. An example of written coordinates for Sirius are Right Ascension (RA or α) 6h 45m 8s & Declination (Dec or δ) –16° 42' 58".

Deep Sky Objects (DSO)

What are DSOs? Basically, they are far away and fainter objects that are not single or double stars or any object in our solar system (Sun, Moon, planets comets, asteroids).

Except for galaxies, all Deep Sky Objects reside within our Milky Way Galaxy. Yes, other galaxies do have their own DSOs but these are way too small to see in most scopes. Here is a description of the six types of DSOs:

1. Cluster of Stars. The Pleiades is a visible-to-the-eyes example but most are much smaller and fainter needing a telescope. All stars are born in clusters from nebulae and most clusters eventually disperse.

2. Globular Clusters. 10,000 or so stars packed in a ball, gravitationally bound. About 200 of these are associated with out galaxy. In small telescopes, these look like cottonballs. In larger scopes around 15 inches plus, they are *beautiful* because you see many of the individual stars.

3. Nebulae. Giant clouds of hydrogen gas. Many of these clouds are where stars are actually being born like in Orion's nebula. Some are more dormant.

4. Planetary Nebulae. These have nothing to due with planets, except that many are roundish. When some stars die, they shed their outer "atmosphere" which expands outward and create beautiful shells. The Ring Nebula in Lyra is a favorite. Our Sun will most likely create a planetary nebula.

5. Supernovae. Nebulae that are the remnants of large stars that explode at the end of their lives.

6. Galaxies. These are the farthest and largest observable objects, although most are relatively small in the telescope because of their distances. "Islands" of multi-million to billions of stars, just like our Milky Way Galaxy. There are two basic shapes with many variations.

History. In the mid to late 1700s, a Frenchman named Charles Messier, from Paris, compiled the first catalogue of Deep Sky Objects because he realized no such catalogue like it existed. His catalogue listed 110 of the biggest and brightness objects visible from the northern hemisphere. William Herschel obtained a copy of Messier's third catalogue and got inspired, cataloguing 2,500 DSOs. Dreyer in the late 1800s compiled catalogues listing over 13,000 DSOs.

Light Pollution & Seeing

Cities are getting bigger and there seems to be less "country" every day. You may have to get out of town for darker skies.

On another note, atmospheric turbulence varies from night to night and is dependent on the weather. The turbulence is especially noticable when observing the Moon or planets. A "Seeing' scale of 1 to 10 is often used to refer to the steadiness of the sky, where 1 is the worst. When 1, the Moon and planets appear blurry even using low magnifications.

What can I see with the naked eyes?

Obviously, you can see stars, especially the Sun (remember, the Sun is a star!) and there are the Moon and planets. The planets that are easily seen are Venus, Mars, Jupiter and Saturn. At times, Mercury can easily be seen for several days but you have to know when and where to look because it rises and sets very close to the Sun. Uranus and Neptune are too faint to see with the eyes. And, there is the occasional comet but most comets are only visible in telescopes.

Several Deep Sky Objects can be seen with the eyes. The Andromeda Galaxy appears as a hazy spot. Omega Centauri, the largest Globular Cluster in our galaxy appears as a faint star. The Pleiades is the best example of a cluster of stars plainly visible to the naked eyes but a few others can be seen, in dark skies, as faint, fuzzy patches, especially using averted vision.

And, then there is that Milky Way Band which is fantastic during the summer months but only in dark(er) skies.

Southern Hemisphere snapshot

The creation and naming of all the constellations were conducted by northerners. The Greeks could not see deep into the Southern Hemisphere so other visiting Europeans from the 1600s to the mid 1700s created the Southern Hemisphere constellations.

The very closest stars to Earth, Alpha (α) Centauri (4.37 light years & visible to the eyes) and Proxima Centauri (4.25 light year & not visible to the eyes) are Southern Hemisphere stars. The Southern Hemisphere bears the best views of the largest globular cluster, Omega (ο) Centauri, containing a million stars or so.

There are also the Small and Large Magellanic Clouds which look somewhat like detachments of the Milky Way Band but are irregularly shaped dwarf galaxies bound to our galaxy.

There is one area in the southern Hemisphere that is loaded with clusters and nebulosity situated around the constellation Crux, but overall, the northern hemisphere has slightly better observing. Living near the equator would be ideal because one has access to the whole celestial sphere.

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North Star forever?

Because the Earth spins on its axis, it acts like a top and points to the same spot in space—very close to Polaris, the North Star. But, also like a top, it has a wobble that takes over 25,000 years to complete. 4,600 years ago, our Earth's axis pointed to a faint star called Thuban in Draco. It will get near to Vega in Lyra 13,000 years from now but not close like Polaris. We are lucky to live during a time to have a bright North Star!