Trinity Grace Fellowship

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Conference Theme

The Biblical View of the Zodiac: The Clock of the Gentiles

Session Title

The Astronomy of the Zodiac: Establishing a Technical Vocabulary

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I. Abstract

To have a physical "feel" for the relationship between the Zodiacal Signs and the Earth's Seasonal Calendar, it is important to understand the *astronomy* of the Earth's Orbit and its relationship to the Sun and the Zodiacal Signs. This presentation will review and define the technical vocabulary to help better our understanding of the astronomy of the Earth. Astronomical terms such as "ecliptic", "obliquity", "perihelion", and more will be defined.

2. Introduction

When discussing the Biblical view of the Zodiac, usually one of two possible reactions occurs. First, either the party thinks one is crazy, because he/she is under the false understanding that the Biblical view of the Zodiac is equivalent to modern-day "astrology", or secondly, they are fascinated because they are interested in anything sounding "far out". The later case is someone who loves his or her "ears tickled". Rarely do professing Christians have an interest because of the "text". Only after a reasoned discussion do professing Christians see a glimmer of light in the true meaning of the Zodiac - the Biblical meaning!

The purpose of this session is to provide a technical vocabulary for our current discussion of the Mazzaroth, as well as, further research for those interested.

Important Word Meanings

To mitigate both of the misunderstandings above it is wise to properly define the terms used throughout this session and most probably the other sessions. These terms are:

1. **Astronomy**
   "Astronomy" is an English word transliterated from the compound Greek Word, comprising *αστηρ* meaning "star" and *νομος* meaning "law". The idea behind this word is a "laws of stars", or by extension the study of the motion of stars. This study is a branch of the empirical sciences and is therefore based on observability, repeatability, testability[1], and falsifiability[2].

2. **Astrology**
   "Astrology" is an English word transliterated from the compound Greek word *αστηρ* meaning "star" and *λογος* meaning "study", "dynamic", or "articulation". The idea behind this word is a "study of the stars and their relationship to each other and humankind", in other words, "what do the stars tell us". It has already been shown (SER: Session 1) that Biblical Astrology comes directly from the Creator Himself, whereby the Zodiac was provided to the Antediluvian World to tell the story of the Coming Savior. In this sense, the original intent of the Zodiac was indeed to provide a "horoscope", but a horoscope of one Person, namely Christ the Savior of the Righteous Gentile Nations and the Messiah of Israel. Modern-day Astrology is a Pagan corruption of the original intent. It is now a horoscope of anyone who wishes to find some artificial meaning in the stars or to predict the future, or provide details as to one's character. The Zodiac's corruption is first alluded to in Gen 4:26.

It is important to recognize that both Biblical Astrology and its corruption represented by modern-day Astrology are not empirical sciences. Biblical Astrology is based on God's revelation in Scripture, while modern-day Astrology is based on the whim of man.

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[1] For an endeavor to be considered an "empirical science" the elements within that endeavor must be observable by man within his lifetime, also, he must be able to repeat similar observations with the same results, and he must be able to construct experiments to verify his hypotheses. In this sense, Astronomy is less empirical than say the branch of physics called Classical Mechanics, since much of what we have in Astronomy is not assessable by man to observe with test equipment. This is due to the fact we simply can not get "out there" and observe close up, repeat close up observations, and construct tests within the laboratory of the cosmos. More could be stated here, but would be beyond the scope of this presentation.

[2] Sir Karl Popper first espoused the notion of "falsifiability" as a characteristic of the "empirical sciences". Later he "lightened up" on the idea. The Author believes that in some sense Popper was correct in the first place and should never have moved from his original position. See Karl R. Popper, **The Logic of Scientific Discovery**, Routledge, New Your, NY, 1992; For additional reading see Rousas John Rushdoony, **The Mythology of Science**, Craig Press, Nutley, NJ, 1979. For a discussion of specifics within modern-science see Phillip W. Dennis, *Probability and Quantum Mechanics: A Christian Theistic Interpretation*, **Proceedings of the Fourth International Conference on Creationism**, R.E. Walsh Editor, Creation Science Fellowship, Inc., Pittsburgh, PA, 1998, pp. 167-200. In the Author's opinion Dr. Dennis' paper remains unanswered by the Scientific Creation community as well as the Intelligent Design (ID) movement. This latter statement should in no way be taken that the Author is not an "orthodox" Creationist, but rather states that the modern Creationist movement is addicted to "evidentialism" - an apologetic approach that is inconsistent with the Biblical World View or Presuppositional Apologetic. Also, it should not be assumed that Biblical Creationism is equivalent to Intelligent Design. The Author maintains that the ID movement is also in great apologetic error for the same "evidentialistic" addictions as the modern Creation movement.

3. General Astronomy

In this section general astronomical terminology is defined: Beginning with a discussion on stars, moving out to galaxies, then turning back to our own solar system, and finally returning home to planet Earth. We begin this assignment with a discussion on the determination of astronomical (or celestial) distances.

3.1. Celestial Distances

Objects in the sky are not close. In fact, they are quite far from the earth and our solar system. Since objects tend to be far away, how do astronomers determine the distances of celestial bodies? There are several methods that astronomers have developed to determine the distances of celestial bodies and they fall into essentially two categories:

1. Indirect Methods
2. Direct Methods

3.1.1. Indirect Methods

In this section we shall briefly describe some (not all) of the more popular indirect methods of determining the distances of celestial objects. These methods are said to be "indirect" because they require the measuring an another variable(s), then from that measured variable(s) determining its distance through a mathematical relationship held with the object's distance.

Cepheid Variables
In this method the arithmetic relationship between the object's luminosity and distance are used. The luminosity of the Cepheid varies with a certain measurable periodicity, which is directly related to its distance.

Luminosity -> Period -> Distance

Stellar Color
By capturing a star's light and running it through a prism, the specific spectral lines that are produced act as "fingerprints" for that star, from which the temperature of that star can be calculated. Once the temperature of the star is calculated, Stefan's law in tandem with the Hertzsprung-Russell Diagram [HRD] (see below) is used to calculate the star's distance.

Hubble's Law (The Expanding Universe)
In the 1920's Edwin Hubble discovered a relationship between a galaxy's speed and distance from the earth. He found that the farther a galaxy is away from the earth, the faster it is moving away from the earth. This was the discovery of the expanding universe model. The question for us is how does one calculate the speed at which a galaxy is speeding away? The method is called the "Doppler Effect". As you might have experienced, when a train blows its whistle and the train is moving toward you, you hear the pitch (or frequency) of the whistle increase, then as it passes you by, you hear it decrease. This phenomenon is called the "Doppler effect" and is caused by the relative motion of the source (in our case the train or a speeding galaxy) to the observer. In the case of celestial objects, instead of listening to the audible sounds made by a moving train whistle, the astronomer "listens" to the light of a celestial object as it moves in space and observed on the earth. If the galaxy is moving toward the earth, the frequency of the light is raised, similar to the frequency of our train's sound waves as the train approaches the listener's position. Moreover, as a celestial object is moving away from the earth, its light frequency is lower. The raising of the frequency of light, gives the appearance of "bluing" the light, while the lowering the light's frequency gives the appearance of "reddening" the light. Most celestial objects show a "reddening" of their light, meaning that the galaxies are moving away. From this "light shifting" the speed of the celestial object can be calculated, and from its speed its distance can be determined - the greater the shifting of its light, the greater the object's speed. Upon determining the speed of the celestial object, using Hubble's formula its distance can be determined:

V (Speed of Object) = H (Hubble's Constant) * D (Distance of Object)
… solving for D
D = V / H

Because most celestial objects show a reddish shift in their spectrum, they are considered to be moving away from Planet Earth. This shift is called the "Red Shift" and refers to the shifting of the object's light frequency toward the red end of the spectrum.

3.1.2. Direct Methods

The most direct method of determining the distance of celestial objects is called Parallax. To best understand the method of Parallax recall as a child sticking your thumb up on your out-stretched arm, closing one eye, then opening it, and closing the other. You observed a shift in the position of your thumb against the background to which you were looking. The reason for this shift in position is seen in the following figure:

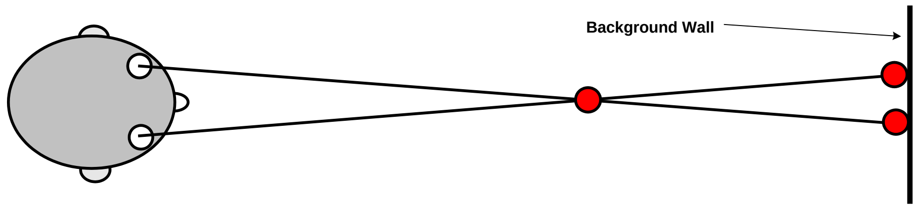


Figure 1. Eye-Ball Parallax

The shift that you observed was due to the distance between your eyes. You observed your thumb from two differing angles (one from each eye) and you observed on the background a shifting of your thumb's position. In your childhood, if you were a true geek, you may have set up an experiment to measure the degree of shift and in turn try to calculate the distance of your thumb. Now let's take a look at the analogous method we have in Stellar Astronomy.

Imagine your two eyes to be at opposite points along the earth's orbit and your thumb to be the star in which you are interested. Consider the following figure.

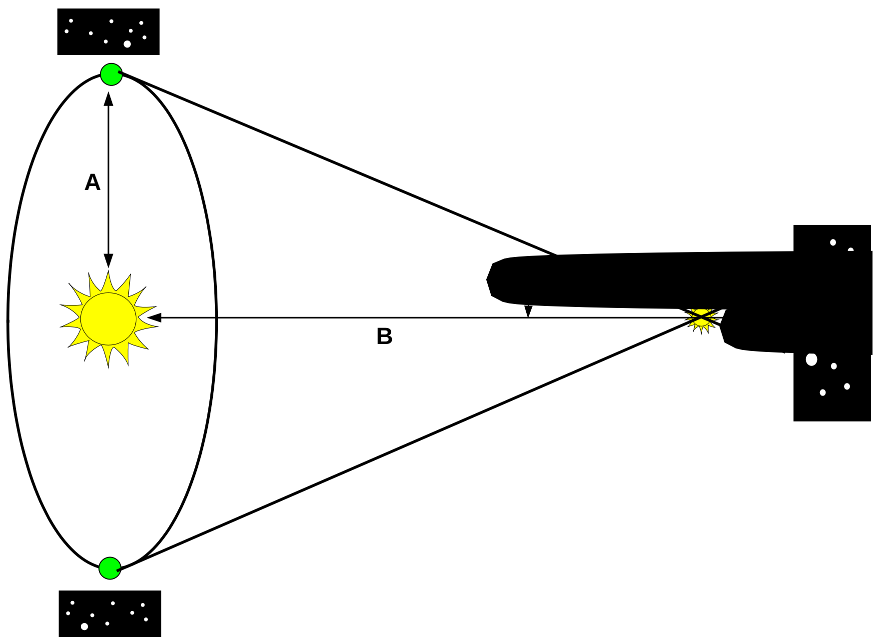


Figure 2. Stellar Parallax

Notice that the larger star, the one in which we are interested, is on one side of the photo, then 6 months later (1/2 revolution of the earth) the same star has moved within the photograph. If the photograph is calibrated the distance of the star's shifting can be measured to determine the angle Θ, and from the trigonometric relationship,

$$\tan \Theta = A / B$$

solving for **B**

$$B = A / \tan \Theta$$

Because the radius of the earth's orbit is a finite distance, the Parallax Method is only good for so many light years, after which the uncertainty in the measurement of the angle Θ (Parallax Angle) causes this method to fail. Of all the stars that exist, stellar distances for only 120,000 are able to be determined by Parallax.[3]

3.2. Stellar Astronomy

Stellar Astronomy is the "study of stars" or the "astronomy of the stars". This field of endeavor concerns itself with the laws that govern the motion, life, make-up, and interaction of stars. According to modern-day science, a star is a gaseous ball burning at tremendous temperatures and giving off remarkable energy and nuclear particles. Generally, hydrogen gas is the major constituent of a star.

3.2.1. How Do Stars Burn?

A star "burns" by the process called "nuclear fusion". Nuclear fusion is the process of atoms coming together and "fusing" to form new and more complex atoms, and is the opposite of "fission" - the process of breaking up atoms. To best understand this process, let's look at the nuclear process of fission first, then examine fusion.

The following figure illustrates the nuclear reaction called fission.

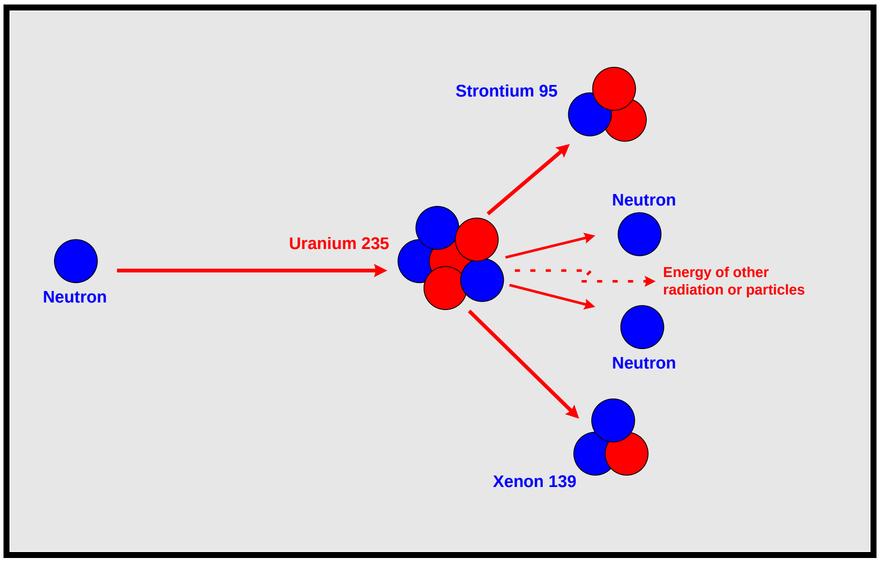


Figure 3. The Fission of Uranium 235 with a Slow Moving Neutron

As the figure above illustrates, fission requires a neutron (or a similar atomic projectile) to be "shot" at an uranium atom. The neutron "impacts" the uranium atom, similar to a cue ball hitting a set of billiard balls, and splits the uranium atom into essentially two fission fragments, some loose neutrons, and some energetic radiation. Similar processes are used in nuclear reactors, whereby the energy given off by the fission reaction is harnessed and used to generate steam, which then drives turbines and electric generators - producing electricity for cities and communities. Another similar application of fission was the atom bomb (or A-bomb), dropped in Hiroshima and Nagasaki in 1945 bringing an end of WWII. As might be expected from the figure above, the fission process creates by-products that are not always "human-friendly", requiring their careful disposing.

Generally speaking, "man controlled fission" consists of taking larger atoms and splitting them into smaller ones, rather than starting with small atoms and making even smaller atoms.

As mentioned above, the opposite nuclear process of fission is called fusion and is illustrated in the figure below. In this figure, the hydrogen isotopes, deuterium and tritium are utilized. With extreme energy, these two hydrogen atoms are "hurled" toward each other, combining to form a very unstable product of a helium nucleus and an extra neutron. This arrangement then breaks down to helium, an extra neutron, and extremely high energy in the form or radiation or particles.

[3] Until 1989 only a "handful" (a bit of an Understatement) of stars could have their distances calculated accurately by Parallax. The Hipparchus Satelite was launched by the European Space Agency, and it was used to accurately deteremine the distance of stars by Parallax. Its precision was immensely improved and we can now determine the distances of more than 120,000 stars.

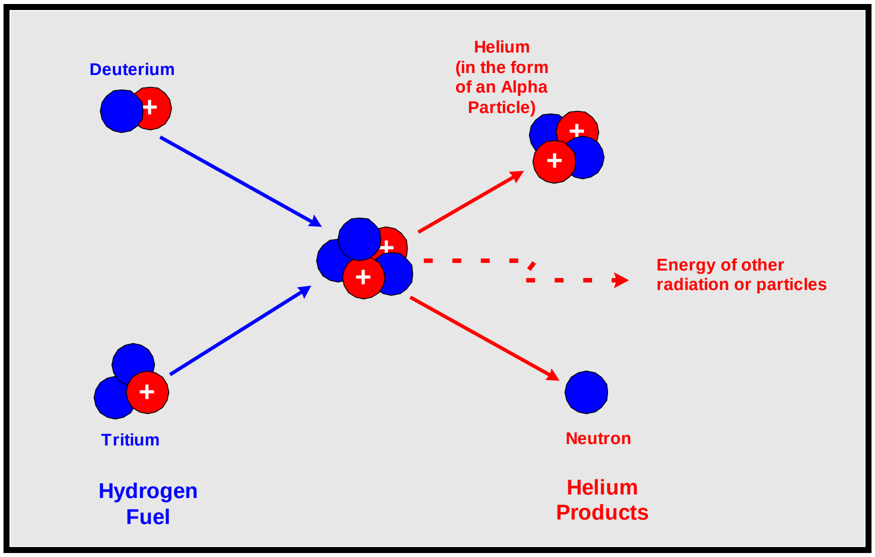


Figure 4. The Nuclear Fusion of Hydrogen to Helium

For reasons beyond this presentation, fusion generally releases more energy than fission. An example of an application of the fusion process is the Hydrogen Bomb, far more powerful than the A-bomb. Currently, technology requires extremely high temperatures to generate sufficient energy for the hydrogen atoms to "fuse". This has caused a flurry of research into what is called "cold-fusion" - fusion occurring at room temperatures, or much less than typically required.

Fusing hydrogen atoms into helium atoms causes the "burning" of stars (including our sun). Modern theory states that within a star, the pressures and energies are such that the energetic hydrogen atoms fuse to form helium and in larger stars, more complex atoms (e.g., carbon, nitrogen, oxygen, etc.).

A simplified reaction is as follows:

$$4\ [{}^{1}_{1}\,H] \text{ -----> } [{}^{4}_{2}He] + 2\ [{}^{0}_{+1}\,e] + 2\,\nu + Q$$

Four Hydrogen atoms (H) combine to form one Helium nucleus (He)[4], 2 positrons[5] (e), 2 neutrinos (ν), and large amount of energy (Q). Besides Helium other products can be produced such as carbon, nitrogen, oxygen, and so on. Larger stars can create higher end atoms as mention above.

3.2.2. Stellar Properties

In this section we shall discuss some very important characteristics of stars that astronomers are interested in and utilize to classify and categorize stars.

Size

The sizes of stars vary greatly. Our sun, which is considered to be an "average" star, is 863,000 miles in diameter, more than 100 times the diameter of the earth. The smallest stars called dwarfs are very small relatively speaking. Red Dwarfs have a similar mass to our Sun, but are about one tenth of its diameter, while White Dwarfs are about 1% of our Sun's diameter.

Next we come to the larger stars. Red Giants are stars that are burning more helium than hydrogen and are considered to be at the end of their lifecycle. Their sizes range from 10 to 100 times that of the Sun. Next are the Super Giants, which can be as large as our entire solar system. Some super giants that you may have heard of are Canopus, Aldebaren, Antares, and Betelgeuse (see below).

Neutron Stars are stars that have collapsed upon themselves, resulting in the electrons of the star's atoms to have fallen upon their nuclei, and canceling out the positive charge of the protons. The result is a net charge of zero. Typically, Neutron Stars have roughly 3 times the mass of our Sun, but only 20-km in diameter.

[4] Another name for a Helium Nucleus is "Alpha Particle"
[5] A "positron" is actually a positively charged electron and is the anti-matter analog to an electron.

Black holes are theoretical objects that allegedly form when larger stars finish "burning" and the gravitational force far outweighs the star's internal pressure. The star collapses upon itself causing the gravitational force to increase to such a degree that nothing can escape its gravity - not even light (hence "black" hole"). If our Earth shrunk to become a "black hole" all of its mass would be within the diameter of a "marble", while our Sun would have to collapse to a diameter of about 4 miles. Some very interesting theoretical astrophysics has been generated around the concept of black holes, with their ability to trap matter and light, and their "warping" of space-time they have made for some interesting science fiction.

Temperature and Color

The temperature and color of stars are related just like many of our every day experience with flame. Consider a flame generated by a propane torch. The flame is blue in the center and yellowish or reddish at its edges. This is due to the temperature distribution (gradient) of the flame. The "cooler" portion of the flame is toward the flame's edge and hence it is more yellowish or reddish, while the "hotter" central portion burns blue. So stars burning at different temperatures produce different colors. Astronomers have classified stellar surface temperature using the following table.

Classification	Temperature Range (Kelvin - ^{O}K)	
	Low End	**High End**
O	28,000	50,000
B	10,000	28,000
A	7,500	10,000
F	6,000	7,500
G	5,000	6,000
K	3,500	5,000
M	2,500	3,500

Table 1. Stellar Surface Temperature Classification

You can remember this classification by the following "catchy" sentence:

Oh **B**e **A** **F**ine **G**entleman and **K**iss **M**e

Typically, the "hotter" the star the more "bluish-white" it will appear, and the "cooler" the star the more its color will be toward the red-orange-yellow portion of the spectrum - just like our flame example above. Some examples of star temperature-color classification are:

Typical Colors and Classifications		
Celestial Object	**Classification**	**Color**
Our Sun (Sol)	G	Yellow
Antares	M	Red
Sirius	A	Bluish - White
Rigel	B	Bluish - White

Table 2. Classifications of Some Well Known Celestial Objects

Note the temperature ranges in each category. These are the temperatures of stars at their surface. The internal temperature of a star can reach to greater than 15 Million degrees, providing the energy to sustain the fusion process.

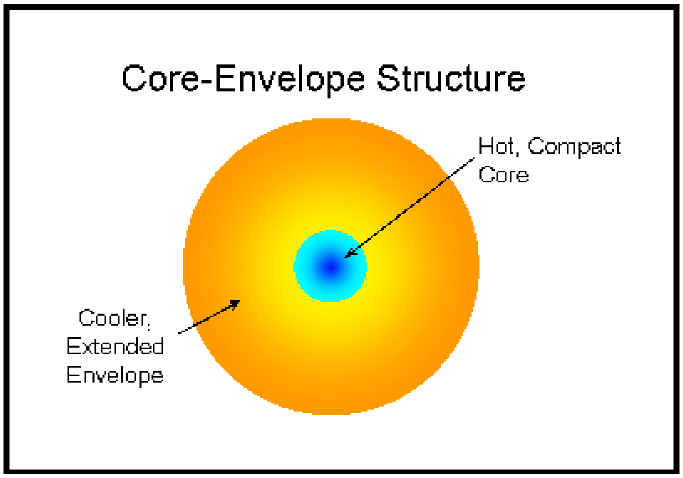


Figure 5. The Temperature Profile of a Star

The figure above illustrates what is thought to be the typical "thermal stratification" (layering) of a star. The internal core of a star is at an extremely high temperature on the order of at least 15-20 Million degrees Kelvin, while the surface the of star is a "mere" 2,500 to 50,000 degrees Kelvin.

Luminosity

The Luminosity (L) of a celestial object is the total energy (all wavelengths) that an object gives off in 1 second. It is actually the "power" given off by an object. The familiar term "watt" (J/s) is a unit of power and is also used to measure the power of light bulbs. Similarly, stars are measured in the same manner. The Sun for an example puts out a smashing 3.84×10^{26} Watts (Joules/Second) - that's one mean light bulb!

According to Stefan-Boltzmann's Law, the Luminosity of a star is dependent upon its radius (R) and its temperature (T):

$$L = 4\pi R^2 \sigma T^4$$

where,

σ - Boltzmann's Constant = 1.38054×10^{-23} J/K (Joules per degree Kelvin)

Apparent and Absolute Magnitude

The apparent magnitude of a celestial object is nothing more than how it appears to Earth. How we see it. How is the absolute magnitude of an object determined? To understand the difference between the absolute and apparent magnitude let's look at the following figure.

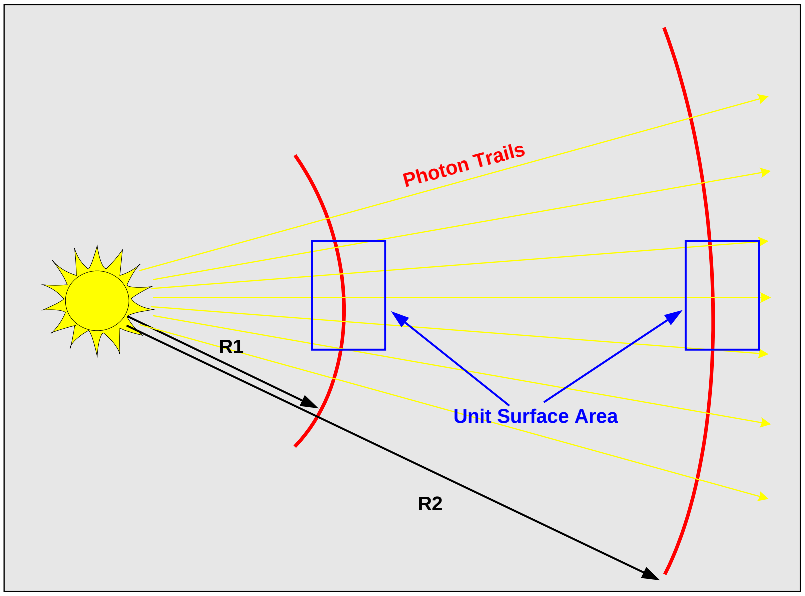


Figure 6. An Object's Apparent and Absolute Magnitudes

In the figure above consider R2 to be the radius of a great sphere with the star in the center and the Earth laying on that sphere. The star in the figure above would have an apparent magnitude based on the distance (R2) from the Earth. This would be the magnitude that we observe the star to have at the Earth.

The absolute magnitude of an celestial object is nothing more than the apparent magnitude calculated at a standard distance R2, defined to be 10 Parsecs.

Notice as the star is farther away from Earth (R2), the "lines of photon flux" get less dense through our viewing window. The apparent magnitude is the measure of the lines of photon flux.

The following figure shows the apparent magnitude or brightness of some well-known celestial objects.

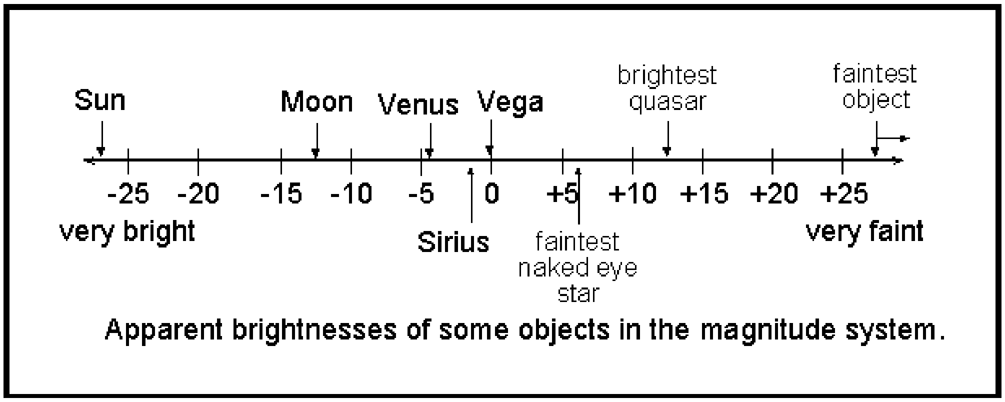


Figure 7. Apparent Brightness

3.2.3. Stellar Classification

Astronomers often classify stars by two characteristics:

(1) Luminosity – the total amount of energy (all wavelengths) being radiated from a star in one second
(2) Temperature – specifically the temperature of the star's surface

By categorizing stars in this manner, they form a pattern as seen in the figure[6] below.

[6] See http://www.astro-w.dk/rummet/stjerner/158309.jpg

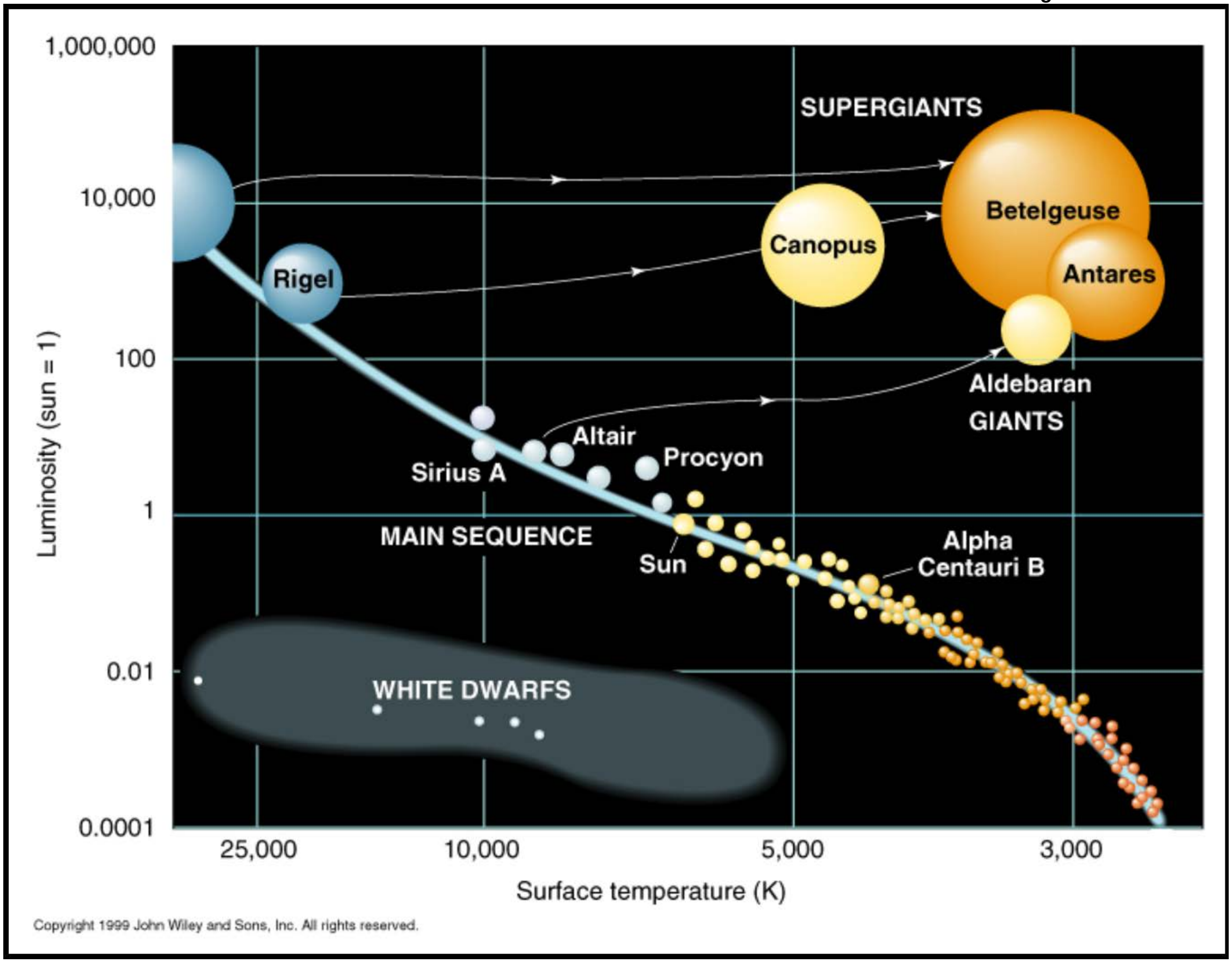


Figure 8. The Hertzsprung-Russell Diagram

The figure above is called the Hertzsprung-Russell Diagram (HRD), named after the two men who independently discovered this relationship. The HRD plots each star as to its Luminosity (w.r.t. our Sun) and Surface Temperature. Note that our sun is approximately 6000 deg K. The majority of stars fall within what is identified as the "Main Sequence", the large wavy line from the lower right corner to the upper left. The Main Sequence begins with small cooler stars and works its way up to the larger, very hot bluish stars, such as Rigel. Other patterns include white dwarfs and the great super giants, such as Antares (Scorpio) and Betelgeuse (Orion).

Another star characteristic of interest to astronomers is size. Our sun is roughly 865,000 miles in diameter and considered to be an average star. Other stars are much larger to use a Figure of Understatement. Often these larger stars were once part of the main sequence as a hot bluish star. Antares is such a star, and is 500,000,000 miles in diameter and is the main star in the constellation of Scorpio. If Antares was centered in our solar system, its diameter would reach out to the farthest edge of the asteroid belt.

Even bigger is Betelgeuse, with a diameter of almost a billion miles; if centered in our solar system Betelgeuse would be well beyond the orbit of Jupiter. Betelgeuse is in the great constellation of Orion and appears as the main left shoulder star as shown below.[7]

[7] See http://www.science-park.info/astronomy/stellar/more/ori_betelguese.html

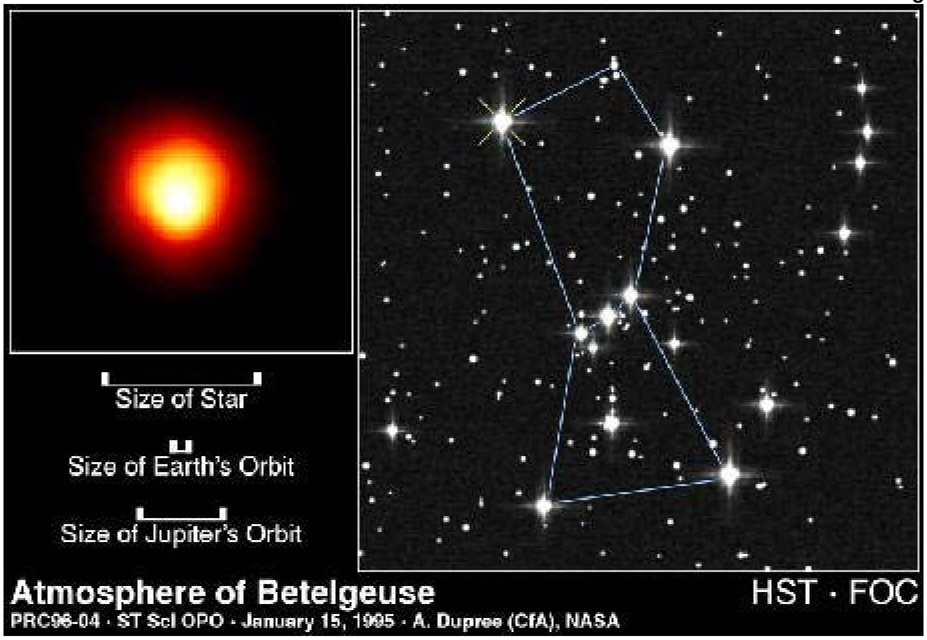


Figure 9. The Diameter of Betelgeuse

3.3. Galactic Astronomy

Galactic Astronomy is simply the study of galaxies, their formation, operation, and interaction. Galaxies are large collections of stars on the order of 100s of Billions of stars. There are essentially 3 types of galaxies:

1. Irregular
2. Elliptical
3. Spiral

Irregular Galaxies

Irregular galaxies are a collection of stars that do not seem to have a cohesive rotating central core. An example of an irregular galaxy is below.

Figure 10. Irregular Galaxy[8]

[8] www.astro.psu.edu/.../ lab11-12images/irregular/

Irregular galaxies tend to be smaller than the great spiral galaxies and are classified into two groups, Type I and Type II. Type I are those Irregulars that have easily identifiable stars, clusters, and nebulae, while Type II do not.

Elliptical Galaxies
Elliptical galaxies are somewhat featureless and range in shape from almost spherical to almost flat. They are measured by their elliptical eccentricity, the ratio of the "small" axis to the "large "axis" (b/a). The following figure illustrates the classification of elliptical galaxies.

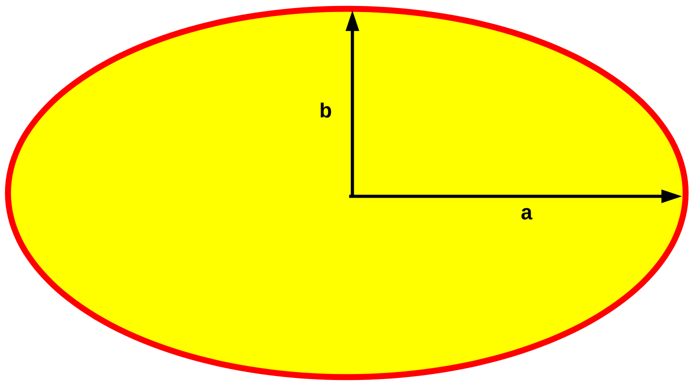


Figure 11. Classifying an Elliptical Galaxy

An elliptical galaxy that is spherical in shape is labeled E_0, while the most "flat" Elliptical is labeled E_{10}. The number suffix (n=1->10) is determined by the ratio of the a/b in the figure above by the following equation:

$$E_n = \{E_0, E_1, E_2, \ldots, E_{10}\} \text{ where}$$
$$n = 10 * (1 - a/b)$$

So that in the case of a spherical galaxy (a=b => a/b=1), hence **n = 0**, while a flat galaxy (b<<a => b/a ~0 and (1-a/b) => **n = 10**). **So the greater the value of n, the more elliptical the galaxy.**

Figure 12. Elliptical Galaxy (M87)[9]

[9] From http://antwrp.gsfc.nasa.gov/apod/image/m87_aat.gif

M87 is a large elliptical galaxy in the constellation of Virgo.

Spiral Galaxies

Spiral Galaxies are perhaps the most interesting in that they have retained a "whirlpool-like" shape and provide for remarkable eye-candy, especially to the astronomer. The figure below provides a fine example of one of the more famous spiral galaxies.

Figure 13. Spiral Galaxy (M51)[10]

The figure above is a photograph of M51 (NGC 5194), the famous Whirlpool Galaxy in the constellation of Canes Venaciti, discover by Messier in 1783. Spiral galaxies are large collections of stars, spinning around a central mass of stars. The Whirlpool Galaxy is a standard spiral except that the spiral arms "seem" to curl back toward the galaxy's center.

Another and perhaps more interesting type of spiral galaxy is called a "Barred Spiral" and is depicted below.

Figure 14. Barred Spiral Galaxy - NGC1365

A barred-spiral galaxy contains a linear band of stars extended out from the central "galactic glob".

[10] From **www.smv.org/ hastings/sC.htm**

Spiral galaxies provide a remarkable limit to the age of the universe. Within 1 or 2 revolutions of a spiral galaxy, the spiral arms loose their distinctive look and almost become part of the main body of the galaxy, whereby the galaxy appears to be a circular or elliptical disc. This is due to the inner stars revolving about the galactic center faster than those farther out. Estimates are that galaxies rotate once every 100,000 to 200,000 years, placing an *upper* limit[11] to the age of spiral galaxies, especially barred galaxies. The barred nature would be lost very quickly.

One of the most spectacular galaxies is the Sombrero Galaxy and is beautifully shown below.

Figure 15. The Awesome Sombrero Galaxy (M104)

The Sombrero Galaxy in the constellation of Virgo represents one of the most spectacular sights for the astronomer.

The Milky Way Galaxy

The galaxy in which we live is called the Milky Way, and is thought to be a Barred Spiral Galaxy. Astronomers have estimated that our position in the galaxy is within one of the spiral arms of the galaxy, about 2/3 radius away from the galactic center. Our galaxy is thought to contain some 200 Billion stars and is on the order of 100,000 Light Years in diameter.

Galactic Groups

The Milky Way is part of a group of galaxies called the Local Group. Galaxies tend to "group" themselves together forming what appear to be collections of galaxies. There are some 45 galaxies in our Local Group, and typically there are 5 or more galaxies in a group. Some well-known galaxies in our Local Group are:

1. Large Magellanic Cloud, orbits our Milky Way Galaxy, and is in the Southern Hemisphere
2. Small Magellanic Cloud (NGC292), orbits our Milky Way Galaxy, and is in the Southern Hemisphere
3. Andromeda Galaxy (M31), the Largest Galaxy in the Local Group
4. NGC 205, is an orbiting Galaxy around Andromeda
5. M32, an Elliptical Galaxy, an orbiting Galaxy around Andromeda
6. Triangulum Galaxy (M33), a Spiral Galaxy about 3000 light-years away
7. Sagittarius Dwarf, is our closest Galactic Neighbor (just recently discovered)

[11] The author is not stating that the universe is 200,000 years old. Processess such as the the rotating galactic arms are an "empirical" measure of age, and provide merely an **upper limit** to the age of the universe. The earth's magnetic field would indicate that an upper limit of 10,000 years is associated with the age of the earth. Biblically, the geneo-chronologies place an age of the earth at about 6-7 thousand years.

Other Galactic Groups include:

1. Sculptor with 8 Galaxies
2. M81 with 11 Galaxies
3. Maffei with 5 Galaxies
4. NGC5128 with 15 Galaxies
5. NGC5194 with 17 Galaxies
6. Canes I with 10 Galaxies
7. Canes II with 22 Galaxies
8. Virgo I with 177 Galaxies
9. Fornax I with 49 Galaxies

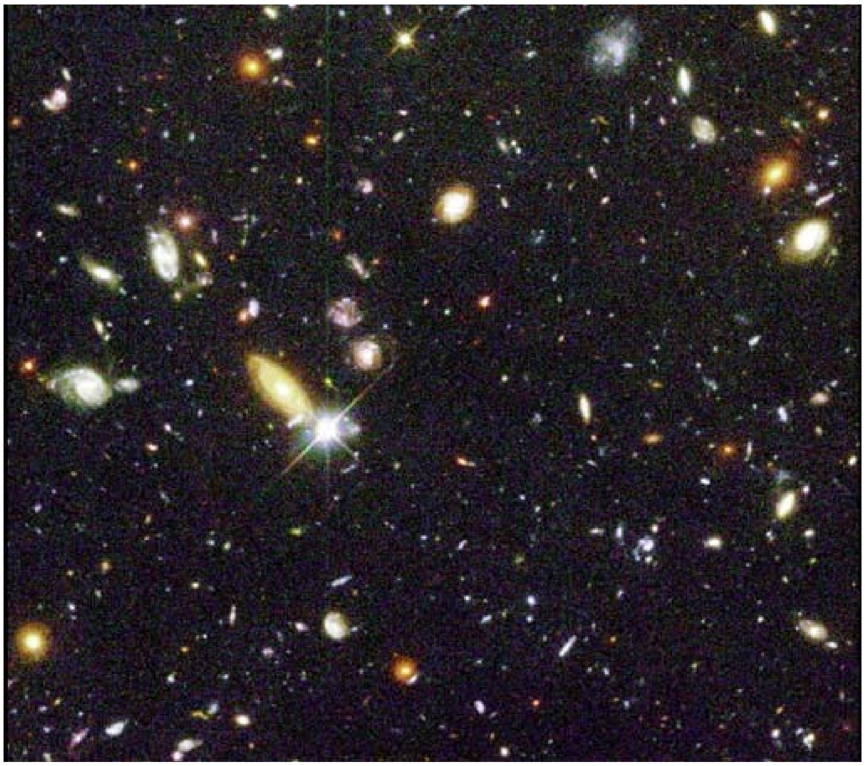


Figure 16. A Remarkable Collection of Deep Space Galaxies

3.4. Our Solar System and Planet Earth

Turning back to our own solar system, we finally arrive at the necessary data needed for understanding much of the vocabulary of the Zodiac.

Our solar system, centered about the star named "Sol", consists of 9 major planets (most with moons), an asteroid belt, a few minor planets, and a host of comets. The planets revolve around Sol essentially in the same plane as indicated in the figure below. This plane is called the "Ecliptic Plane". The 4 most inner planets, Mercury, Venus, Earth, and Mars are called terrestrial planets because they are made up of solid mass. The next 4 planets, Jupiter, Saturn, Uranus, and Neptune are called the "Jovan Planets" because they are gaseous balls revolving around the Sun. Jupiter is so massive that its mass represents almost 1/2 of the entire planetary mass in the solar system. Little is currently known about Pluto and its moon Churn, but it is assumed that it is not a Jovan Planet, but a Terrestrial one. Pluto does not quite lie in the ecliptic plane, but is about 17^{o} inclined out of the plane. Also, Pluto's orbit is more elliptical than the other members of the solar system.

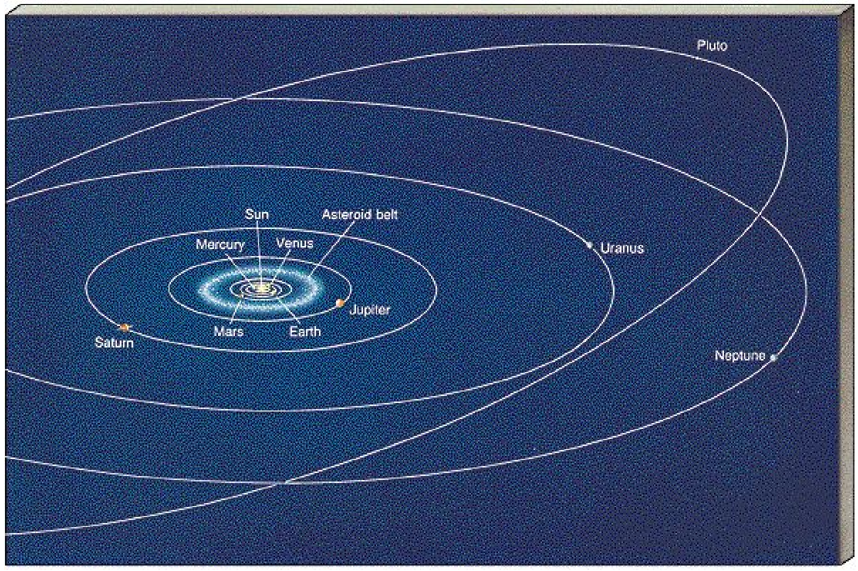


Figure 17. The Plane of the Ecliptic

The following table provides a summary of some of the key characteristics of the planets in our solar system.

Planetary Comparison Table										
Data	**Sun**	**Mercury**	**Venus**	**Earth**	**Mars**	**Jupiter**	**Saturn**	**Uranus**	**Neptune**	**Pluto**
Distance from Sun (million miles)	n/a	36	67	93	142	483	887	1,783	2,794	3,666
Diameter (miles)	865,000	3,031	7,521	7,962	4,222	88,732	74,565	32,311	30,074	1,864
Orbital Period (years)	n/a	88	225	365	2y	12y	29.5	84	165	248
Length of Day	25.4d	58.6d	243d	24h	24.6h	9.8h	10.2h	16-28h	18-20h	6.3d
Average Temp. (Fahr)										
Mass (w.r.t. Earth)	332,948	.06	.81	1	.11	317.9	95.14	14.52	17.25	.1
Orbital Ecc (w.r.t. Venus)	n/a	30	1	2.5	13.8	7.1	8.2	7.0	1.3	37.4
Axial Tilt (degrees)	7.25	2?	177.3	23.5	25.19	3.12	26.76	97.86	29.6	122.46
Number of Natural Satellites	n/a	0	0	1	2	61	33	26	13	1
Gravity (ratio to Earth)	27.9	.284	.878	1	.379	2.4	.923	.793	1.122	.041
Escape Velocity (mph)	138,247	9,619	23,264	25,054[12]	11,185	133,321	79,411	47,647	52,120	2,461

[12] This is essentially the speed at which the Apollo Moon missions had to achieve in order to escape the Earth's gravitation field and make their way to the Moon.

Table 3. A Planetary Comparison

3.5. Planet Earth

Our planet, named Earth, is a remarkable creation, capable of supporting an abundance of life, with a fantastic capability of self-cleansing. Planet Earth receives its energy from the Sun and channels it to be beneficial for life. Earth is the third planet from the Sun ("Third Rock from the Sun") and represents the only habitual planet in our solar system.

In this section we will look at the Earth's relationship to the solar (ecliptic) plane. The following figure illustrates the "tilt" of the earth with respect to the "plane of the ecliptic".

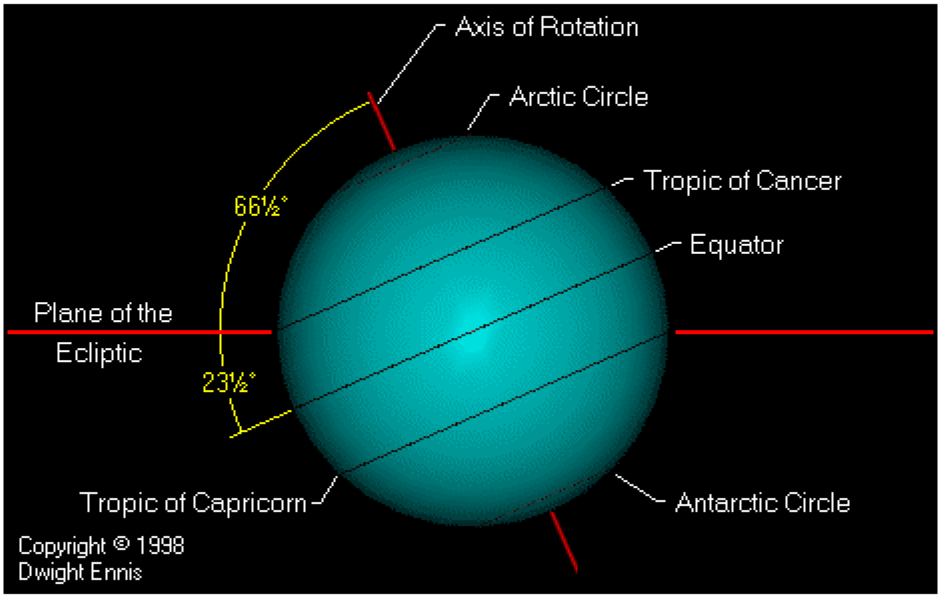


Figure 18. The Tilt of the Earth's Axis

The figure above shows some remarkable things important to our discussion. Note that the Earth is tilted 23.5 degrees from the Plane of the Ecliptic. This angle is called the "obliquity of the ecliptic". Furthermore, the tilt implies that we can easily divide the surface of the Earth up into several parts. First, the equator (0 degrees) to the 23.5-degree latitude line is called the Tropic of Cancer. It is this area that receives the direct sunlight in the Northern Hemisphere summer, while it is the Tropic of Capricorn that receives direct sunlight during the Southern Hemisphere summer. The Arctic and Antarctic Circles are defined to be 23.5 degrees "down" from the respective poles (axis of rotation66 [90 degrees]). The large regions between "tropics" and the "arctics" are called the Temperate Zones (not labeled in the above figure) and are defined to be between 23.5 and 66.5 degrees.

This tilting is the reason we have seasons (the true "reason for the season"). The Earth acts as a "Top" whereby its axis of rotation "wobbles" around a line perpendicular to the plane of the ecliptic. The orientation of the axis of rotation varies slowly and today the northern spin-axis pole "points" to a star in the Constellation of Ursa Minor ("The Little Dipper") called, Polaris ("The North Star"). But because the Earth behaves like a top, its rotational axis "precesses" in the fashion illustrated in the figure below.

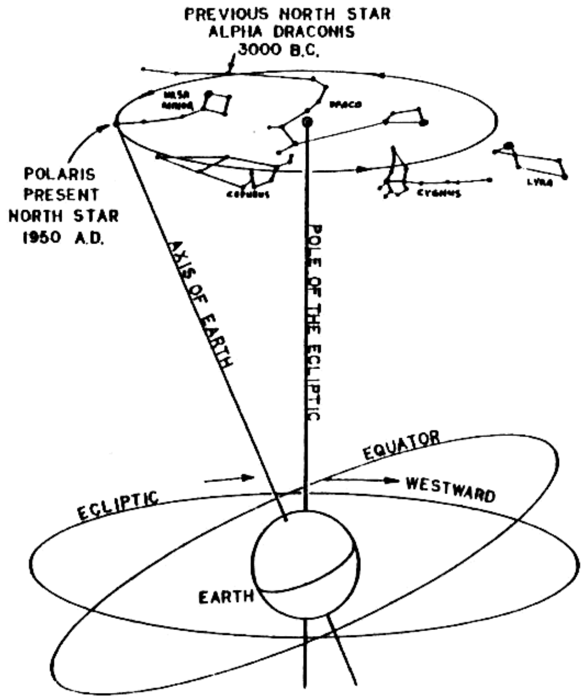


Figure 19. The Precession of the Earth

Precession means that as the Earth rotates on its axis and revolves around the Sun, the orientation of the Earth's' polar axis changes slowly over time. When the Great Pyramids of Egypt were constructed, the polar star was Alpha Draconis in the Constellation of Draco ("the Great Dragon"), while today it is Polaris, and in 14,000 A.D, the polar star will be Vega in the Constellation of Lyra. The orbit of the earth around the Sun is not circular, but rather elliptical. The following figure illustrates the Earth's orbit.

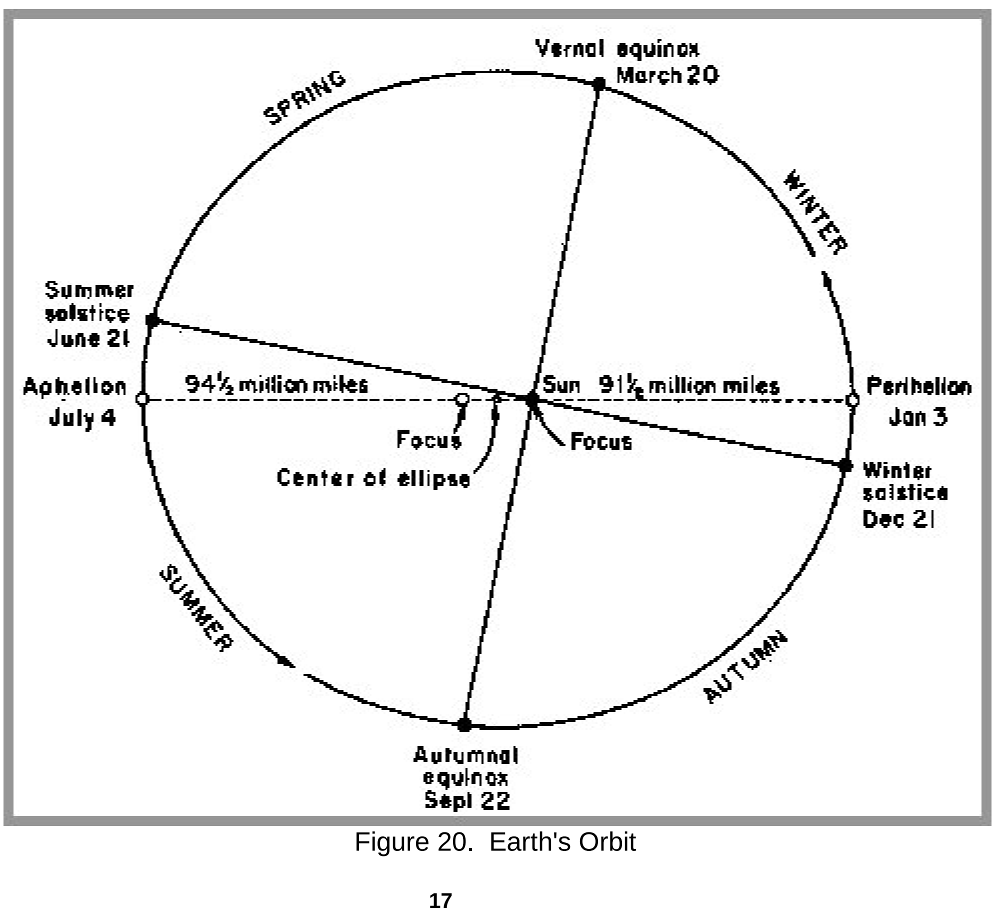


Figure 20. Earth's Orbit

The figure above shows several important key elements regarding the Earth's position and orientation with respect to its orbit. First, because the Earth's orbit is an ellipse, the Earth must lie at one of the ellipse's foci. Because the foci are not coincidental, the distance between the Sun and Earth varies as the Earth revolves around the Sun. For the Northern Hemisphere, the Earth is actually closer to the Sun during the winter months. This location along the Earth's orbit whereby the Earth is closest to the Sun is called its "Perihelion", while the farthest location is called its "Aphelion". Secondly, neither the solstices nor equinoxes coincide with their respective points of symmetry along the Earth's orbit. This is due to the fact that the Earth's "rotation" is not in "sync" with the Earth's revolution about the Sun. Note that this out-of-correspondence correlates to about a 13 to 14 day period. In other words, the summer arrives 14 days too early.

The following figure better illustrates this "out-of-sync" behavior.

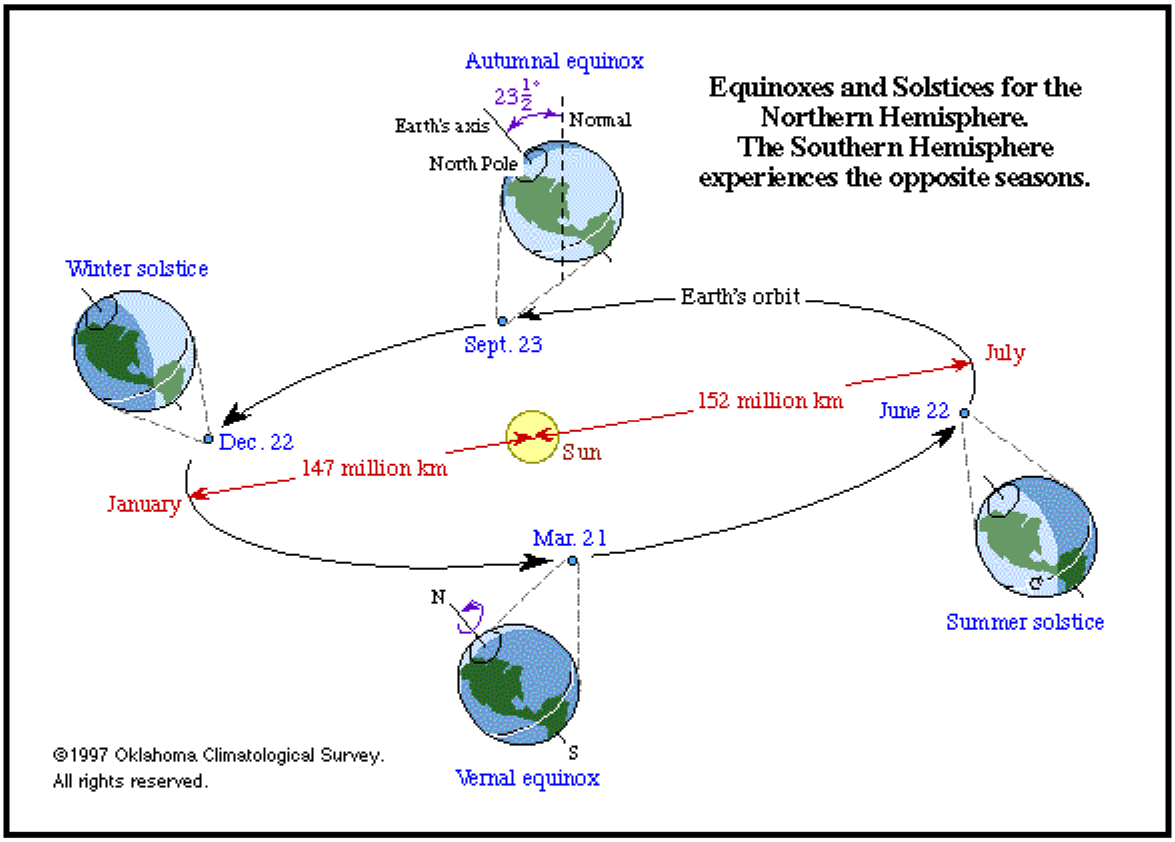


Figure 21. Earth's "Out-of-Sequence" Seasons

This "out of sequence" behavior means that the orientation of the Earth's spin axis is perpendicular to the Sun *before* the Earth arrives at one of its "helions" on its semi-major (short) axis. Furthermore, during the Northern Hemisphere's winter the Earth's spin axis is pointed "away" from the Sun *before* it arrives at its Perihelion. This all effects our weather and how and when we observe things in the heavens. Because the Earth's polar axis is oriented differently at each of its seasons, the Earth receives a differing amount of sunlight throughout the year. The following figure wonderfully illustrates this.

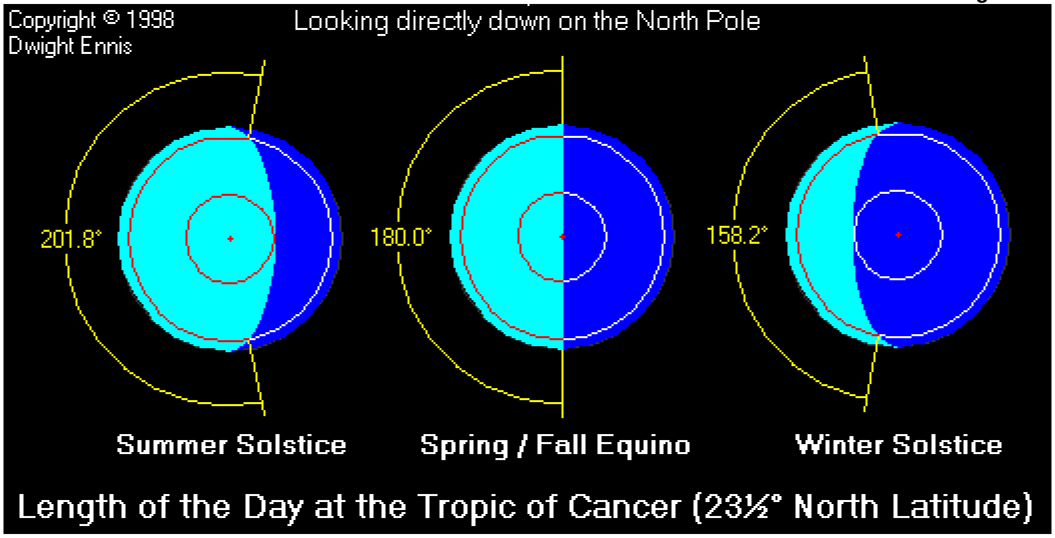


Figure 22. The Length of Day in the Tropic of Cancer

The summer solstice is when the Earth's axis is pointing toward the Sun - this event defines the beginning of summer. The Equinoxes, when both day and night are of equal duration occurs twice a year, defining spring and autumn and occurs when the "plane of the Earth spin axis" is perpendicular to the ecliptic plane. The winter solstice occurs when the Earth's axis pointing away form the Sun, defining the first day of winter.

3.6. The Earth's Orbit and the Zodiac

Now we come to the guts of main reason for this session - to understand the relationship of the Earth, its orbit, and its orientation to the Zodiacal Signs.

The following figure illustrates the relationship of the Earth's orbit and its position within its orbit, to the Zodiac.

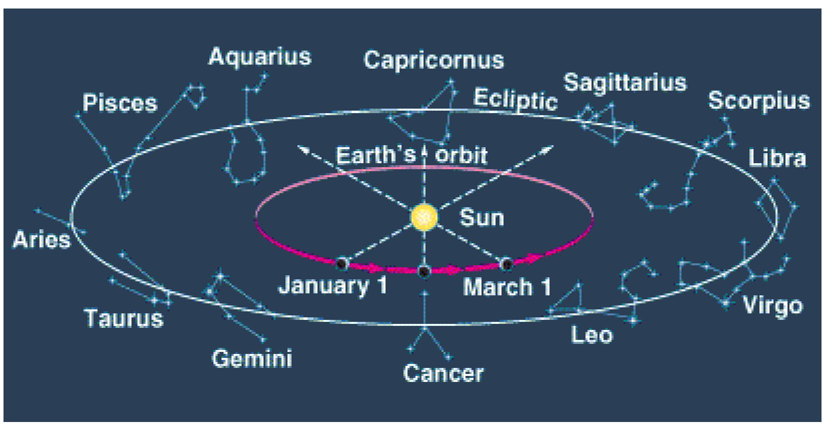


Figure 23. The Earth's Relationship to the Zodiac

The figure above shows how we ought to think about the sky, which we see at night. If at night you are looking up at the sky toward the zodiacal plane in April, you will see the Constellation of Virgo. But if you are up just prior to dawn in late September you will see the Sun rise in the constellation of Virgo. As the Sun rises each day, it appears to move within the Zodiac. Each Constellation corresponds to about 30 degrees so that the Sun seems to rise in each Constellation for about a month.

As the Earth moves about its orbit a new constellation becomes visible to the night sky about every 30 days. The planets trace paths throughout the Zodiac and are often located based upon their zodiacal position.

When a bright star or planet remarkably appears in a Zodiacal Sign just before dawn, it is often called a "morning star". Venus is often a morning star, depending upon its orientation to the Earth and Sun.

4. Appendices

4.1. Definitions

ArcMinute
An Arcminute is 1 degree divided by 60. In other words, there are 60 arcminutes to a degree.

ArcSecond
An Arcsecond is 1 arcminute divided by 60. In other words, there are 60 arcseconds in one arcminute, or 3600 arcseconds in 1 degree.

Astronomical Unit (AU)
An Astronomical Unit (AU) is the distance between the Sun and the Earth (or the radius of the Earth's Orbit around the Sun). 1 AU = 93,000,000 miles = **93 million miles**.

Ecliptic
The plane in which the Earth and Planets revolve around the Sun.

KiloParsec
1 Thousand Parsecs

Light-Year (LY)
A Light-Year is not a measure of time, but rather a measure of distance. It is the distance in which light travels in one year through the vacuum of space. For sake of learning we shall derive this distance.

V (Velocity) = D (Distance) / T (Time) => D = V * T, where V is the speed of light and T is the time (1 year).

186,000 m/s * 3600 s/h * 24 h/d * 365 d/y = 5,865,696,000,000 miles = 5.87 X 10^{12} miles = **5.87 Trillion Miles = 1 LY**

MegaParsec
1 Million Parsecs

Obliquity of the Ecliptic
The angle between the spin axis of the Earth and the Plane of the Ecliptic

Parsec
A Parsec is the distance obtained from the Parallax method, when the Parallax angle is 1 arcsecond and the distance between the Son and Earth is 1 AU. One Parsec is 3.26 Light-years

Speed of Light (C)
The speed of light is typically referred to the speed traveling through a vacuum. It is measured to **186,000 m/s**. In other words, in 1 second traveling at the speed of light, one could make more than 7 revolutions around the earth. Yet, the Sun, which is 93 Million miles away from the earth, requires approximately 8.3 minutes for its light to reach the earth.

4.2. An Astronomical Coordinate System

For an amateur astronomer, the most important coordinate system with which he needs to locate stars and other celestial objects is called the Right Ascension (RA) Declination (D) System. It is a system of coordinates that aid the observer in locating a "height" and "horizontal" position. The following figure illustrates the definition of Right Ascension.

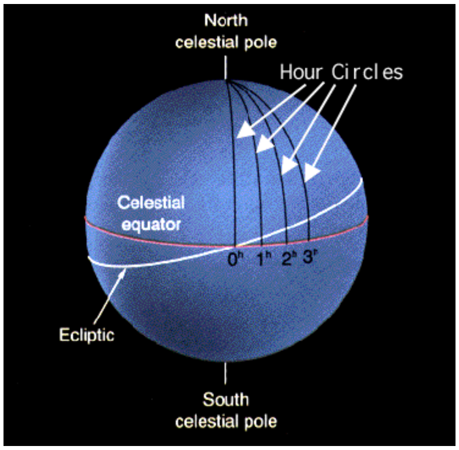


Figure 24. The Definition of Right Ascension

The Right Ascension coordinate is defined to begin on the Earth's surface, where the ecliptic crosses the equator in springtime (called the Vernal Equinox). From that point we draw vertical lines from pole to pole every 15 degrees. Since the Earth rotates every 24 hours, each 15 degrees corresponds to 1 hour of rotation. Thus, we measure right Ascension in Hours, Minutes, and Seconds. The direction of measure is always east to west; thus we go full circle, 0 to 360 degrees. RA is a way in which we can measure the "horizontal" coordinate of an object.

Declination as one might expect, is a measure of the "vertical" position of an object and it begins at the equator as the following figure illustrates.

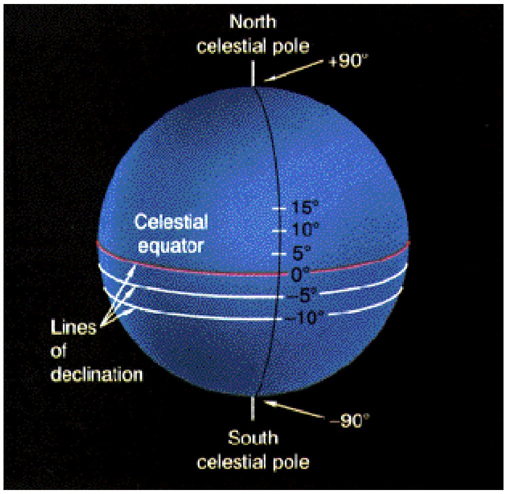


Figure 25. The Definition of Declination

Similar to "latitude" Declination is measured from the equator. If you move north from the equator you move in the positive direction of declination, hence all of the declination coordinates will be positive 0 to 90 degrees. While in the Southern Hemisphere, Declination is measured in negative degrees from 0 to -90 degrees.

Thus, a celestial object will have a Right Ascension and Declination for its location. If your telescope is properly mounted and calibrated, all you need do is set the declination and right ascension to the proper coordinates, and you will find the astronomical object you are looking for.

4.3. A Crash Course in Trigonometry

This appendix includes a look-see into some Trigonometry[13] for those who may wish to dig a little further into this wonderful subject of the Zodiac. Eventually, you'll run into terminology that requires a little knowledge of your High School "Trig" and since it has probably been a long time since sitting in that "interesting" class, a little refresher may not be a bad thing!

In a casual sense Trigonometry has to do with the "measuring of triangles". The specific type of triangle that we will discuss is called a "right-triangle" and is illustrated below along with all of the labeling and identification of constituent elements we will need to understand the basics. Also included in the figure below is the relationship of a right triangle to a circle.

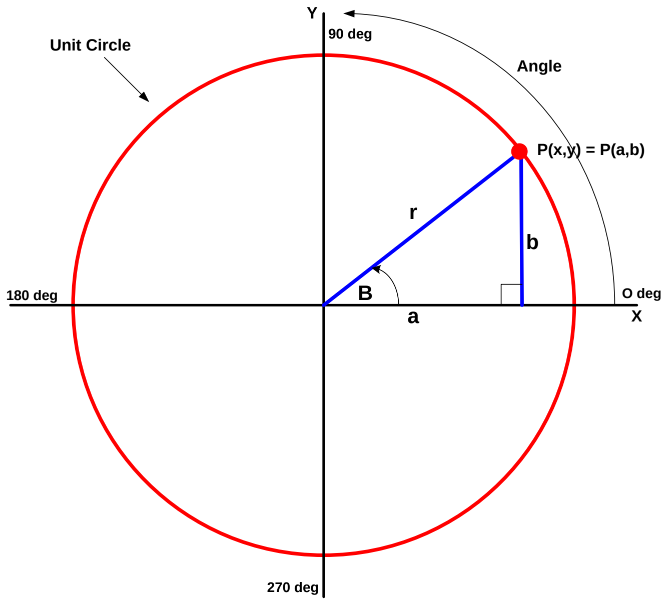


Figure 26. Triangles on the Unit Circle

Where:

B – angle of interest
r – radius of circle and hypotenuse of triangle
a – length of x component of hypotenuse (adjacent to B)
b – length of y component of hypotenuse (opposite of B)
P – point of interest, where the radius intersects the unit circle

What is provided below is a summary of some necessary mathematical relationships used in the examination of triangles.

For any angle B, the following ratios are always the same:

1. The ratio a/r (Adjacent/Hypotenuse) called the cosine of B is the same for angle B.
   - The cosine of B is abbreviated with the following mathematical nomenclature: cos(B)
2. The ratio b/r (Opposite/Hypotenuse) called the sine of B is the same for angle B.
   - The sine of B is abbreviated with the following mathematical nomenclature: sin(B)
3. The ratio of b/a (Opposite/Adjacent) called the tangent of B is the same for angle B
   - The tangent of B is abbreviated with the following nomenclature: tan(B)

The point being that no matter what lengths of the Hypotenuse and Circle Radius are, the value of each ratio is the same.

[13] For this discussion, I must offer my insincere apologies to my dear friend and mathematician Dr. Steve. Any errors in this appendix belong to yours truly!

Think of these ratios as elements unique to angle B. For example the following table provides a list of cosine, sine, and tangent for 0°, 30°, 45°, 60°, and 90° angles (e.g., B=0° or B=30° or B=45° or B=60° or B=90°).

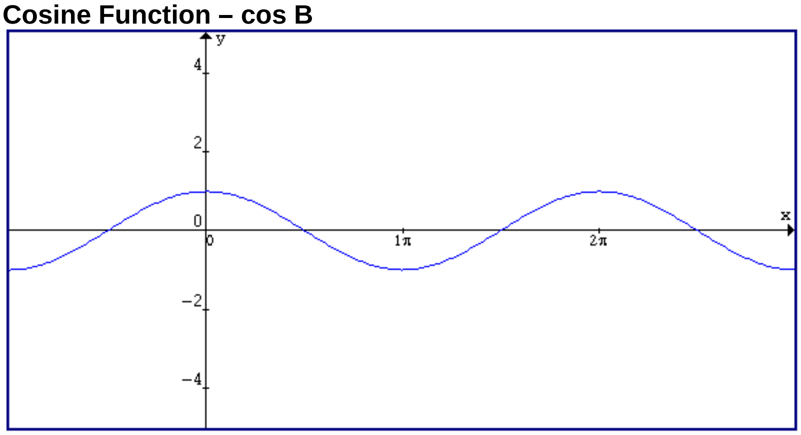
Angle B	**Sine (sin B)**	**Cosine (cos B)**	**Tangent (tan B)**
0	0	1	0
30	.500	.867	.578
45	.707	.707	1
60	.867	.500	1.734
90	1	0	∞

So the following relationships hold true.

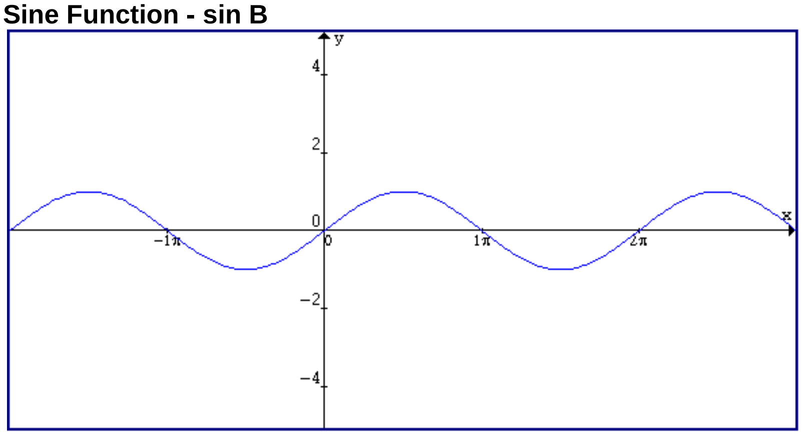
1. a = r * cos B
2. b = r * sin B
3. b/a = tan B

The following graphs illustrate the behavior of these three functions.

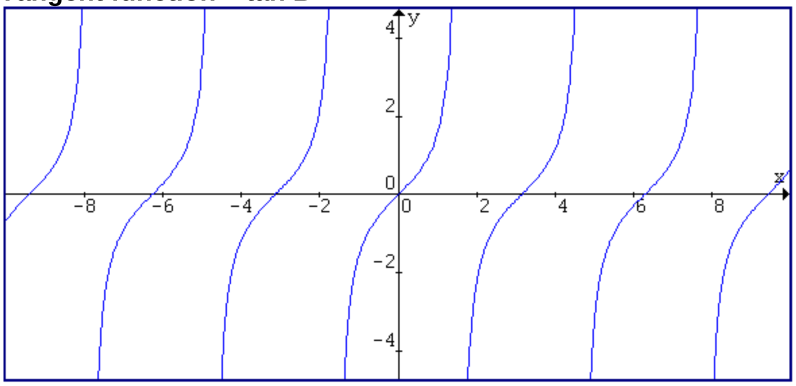
Cosine Function – cos B



Sine Function - sin B



Tangent function – tan B



Little Jimmy, His Wagon, and Trigonometry

Imagine in the figure below, that a little boy, who we shall call Jimmy, watched his morning cartoons and walked out of the house to play with his wagon. Little Jimmy grabbed his wagon's handle and began to pull. Let's suppose that as Jimmy is building up his pulling strength, he exerts 45 pounds of pulling force when the wagon begins to roll.

How much force was required to overcome the friction of the wheels on the ground?

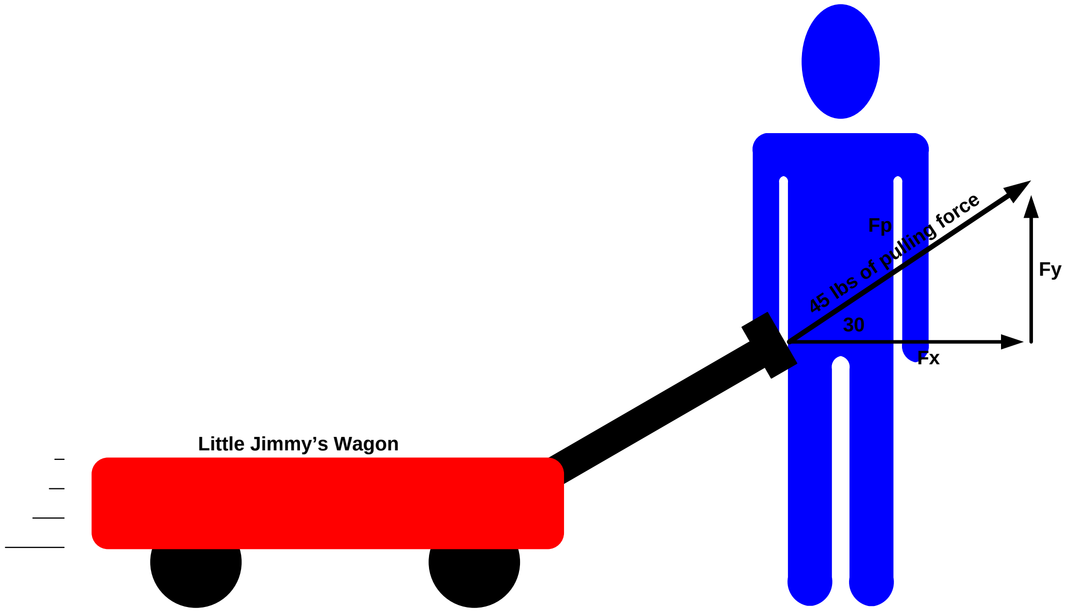


Figure 27. Little Jimmy Pulling His Wagon

Now using our knowledge from our trig discussion, we really want to know how much force Jimmy has to exert in the horizontal direction (X-direction) to overcome the frictional forces. This force is identified in our graphic as Fx and according to our little trig formulas,

$$Fx = Fp * \cos 30^o$$
Or
$$Fx = 45 * 0.867 = 38.97 \text{ lbs}$$

This means that the X-Component of Jimmy's pulling was 38.97 lbs, and this amount is necessary to overcome the frictional forces. What about the Y-Component of Jimmy's pulling force? What is this value?

$$Fy = Fp * \sin 30^o$$
Or
$$Fy = 45 * 0.5 = 22.5 \text{ lbs}$$

Note that if the wagon weighed less than 22.5 lbs, Jimmy's Y-Component pulling force would have "lifted" the wagon off of the ground before it began to horizontally move along the ground. So we can conclude that the wagon weights more than 22.5 lbs.

By the way, Jimmy's frog jumped out of the wagon and was run over by one of its wheels … Jimmy kept on pulling!

5. Resources and Recommended Reading

Carrol & Ostlie, **An Introduction to Modern Astrophysics**, Addison-Wesley, New York, NY, 1996

Hoyle, Fred, **Astronomy**, Crescent Books, London, UK, 1962

Israel & Audouze, **The Cambridge Atlas of Astronomy**, Cambridge University Press, Cambridge, UK 1994

Kaufmann, William J., **The Cosmic Frontiers of General Relativity: A Layman's Guide to the New Universe**, Little-Brown, Co., Boston, MA, 1977

Mehlin, Theodore G., **Astronomy**, Unknown, 1959

Roy & Clarke, **Astronomy: Principles and Practice, 3rd Edition**, Adam Hilger, Philadelphia, PA, 1988

And a host of Web Sites, too numerous to itemize.