

## Introduction to Basic Stargazing Part II

### Measures of Distance:

Distances in our Solar System are often measured in miles, or kilometers for the metrically inclined, in popular news media. More commonly among professionals and hobbyists is the **astronomical unit (au)** – one au is defined as the average distance from Earth to the Sun. There are two reasons for this; 1. It greatly improves computational ease of raw data. 2. It improves comprehension of relative distances.

For example, the astronomical unit is measured at 92,956,000 miles. If you read that Saturn is currently 838,835,000 miles away from us it's a little hard to grasp on the first try. When it is restated as about 9 au – the number is a little easier to understand.

The astronomical unit can also be used inside solar systems other than our own; but to actually measure the distance to these other solar systems the **light-year (ly)** is used. Light-years are defined as the distance light travels in one year, or 5,878,625,000,000 miles (63,241 au). Please note that the light-year is a measure of *distance*, not *time*. The closest star system to our own is about 4.4 light years away – the rest are still further, usually *much* further. Most stars visible to the naked eye are within about 1,600 light-years, although a few, like Deneb, are further.

Popular news media and science fiction works use the light-year almost exclusively, however professional astronomers tend to use the **parsec (pc)** instead. It's an abbreviation of the phrase “**par**allax of one **sec**ond”. Like the astronomical unit, astronomers use it for computational efficiency. It is equal to about 3.26 light-years or 19 trillion miles.

Measuring the parallax of a star is the best and most accurate way of measuring great distances, (land surveyors use it all the time), *if* the parallax can be measured accurately – and there is the problem. The parallax of a star is very tiny and difficult to measure. But there have been constant improvements over the years. Back in the 1950's distances were accurate out to only about 100 light-years, by 1989 we had pretty good measurements out to 1,600 light years. We now have a satellite in orbit gathering data that will give good distances out several tens of thousands of light-years in the very near future.

Astronomers have ways of estimating distances further away, but that is beyond the scope of this article.

There is a lot of stuff in the sky to look at other than the constellations.

**Stars:** Well of course! There are 6 to 10 thousand stars visible to the naked eye; the exact number depends on who is doing the counting. Probably the 6 thousand number is closer to the truth with people of average vision. The number is further reduced by light pollution and haze near the horizon and of course half the sky is hidden from the observer by the bulk of the Earth itself. Two thousand is the best you can hope for in a reasonably dark sky. Many thousands more are revealed in binoculars – I've seen estimates in the million range.

There are many billions of stars in our local area of the Universe (our galaxy); you can see them *en-masse* as the white glow of the Milky Way. Best views of the Milky Way are obtained on early evenings in Summer and Winter as it arches overhead.

Stars are not all white! A very few of the brightest show different colors – red, blue, orange. Your eyes are not as sensitive to color in the dark so the colors can be difficult to discern; also, when we say a star is red, we don't mean red as a stop light, but just a reddish tint. The same goes for other colors.

Sample stars with color:

Betelgeuse, Antares -Red

Rigel, Achernar – Blue

Sirius – Blue white

Aldebaran, Arcturus – Orange

**Planets:** Although fascinating to observe with telescopes, naked eye stargazers are limited to noting a planet's brightness and position – both of which are constantly changing. Six planets are visible to the naked eye: Mercury, Venus, Mars, Jupiter, Saturn and Uranus. (Although Uranus is so dim it is just *barely* visible.) Mercury, although pretty bright, is seen only during twilight where it is a little harder to spot than the average planet. The rest are easy to find as they are among the brightest objects in the sky.

A beginner can identify a planet by printing out a star chart from the internet or a computer program. With some additional practice an experienced stargazer can recognize a planet at a glance. Venus is brighter than anything else in the sky except the Sun or Moon, and can even cast a shadow sometimes. It's impossible to miss. Mars is quite red; Jupiter's moons are clearly visible with binoculars. Saturn is not as bright as the others, but still is brighter than all but a few stars. Its rings are only visible with a telescope however. Uranus is a challenge even under the best of skies; to spot it with the naked eye will take an accurate chart and plenty of patience.

Planets move in very predictable, but extremely complicated patterns. Still some patterns are fairly obvious to stargazers of even modest experience. Inner planets, Venus and Mercury, are never found very far from the Sun. Mercury, in particular, is so close to the Sun it can never be seen outside of twilight. Venus can be moderately high in the sky, but is never seen in the middle of the night and most often is seen shining just above the eastern or western horizon.

Outer planets may be seen any time of the night depending on their exact position. An outer planet is brightest when it is directly opposite the Sun and thus rises as the Sun sets.

For more detail on how planets move around, see part III

Mercury and Venus display phases just like the Moon does, albeit on a very different schedule. Normally these phases can only be seen by telescope. However, for a brief time at its very brightest, Venus displays a tiny crescent phase to people of superb vision. (Typically children). Using binoculars, seeing the crescent phase is simple for everyone.

**Comets:** Comets are dirty snowballs, or perhaps snowy dirtballs is a better description. The classic comet spends most of its time very far from the Sun where it is invisible. As the comet makes an eventual pass near the Sun it is rapidly heated; the snow evaporates violently and escapes the comet and carries some of the dust and dirt along with it. This is visible in telescopes, and if the comet is close enough or large enough, the naked eye. A splendid tail is visible on the best comets, sometimes stretching most of the way across the sky. This is very rare however, perhaps once in a lifetime.

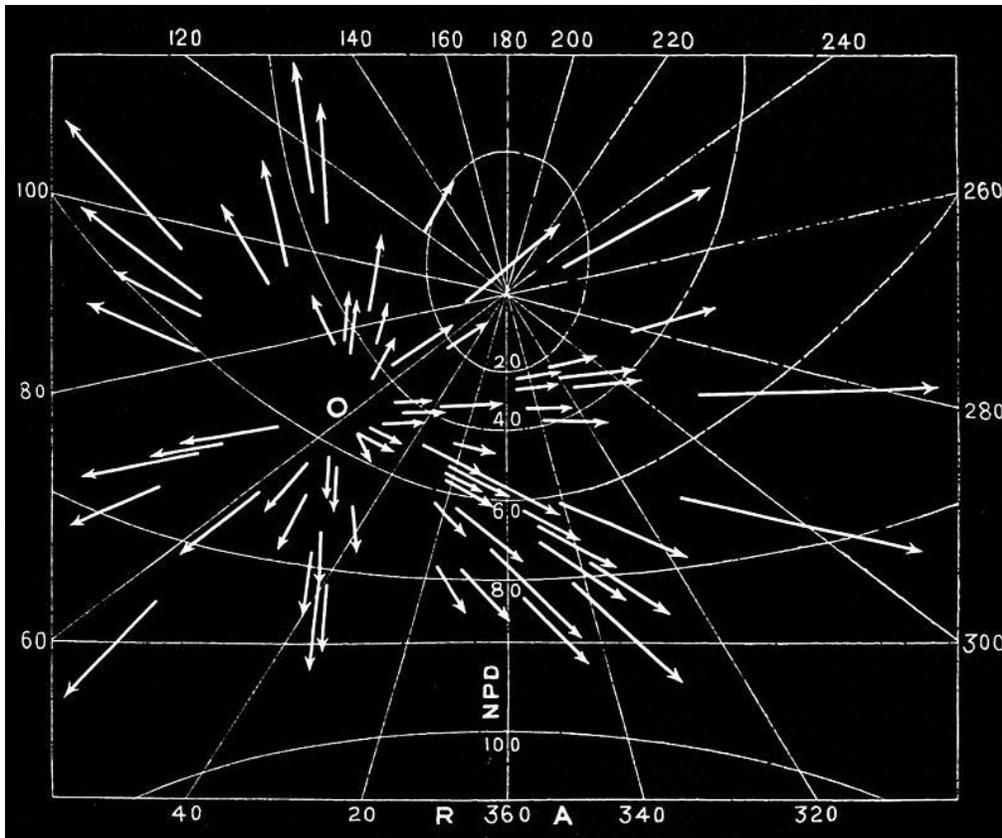
Comets as a group are not rare. At any given time, there are perhaps a half dozen or more comets in the sky, but these are telescopic objects only. About once every two years or so a comet does appear visible to the naked eye in the west after sunset or in the east before dawn.

It is a peculiarity of comets that no matter where the comet is headed, the tail always points away from the Sun. Comets can also have *two* tails, one is of mostly dust, the other gas.

**Meteors:** Remember all that dust and dirt the comets give off? It does not disappear, but continues to orbit the Sun eventually spreading out and filling the entire orbit of the comet. Several times a year the Earth, in its annual journey around the Sun, plows through one of these debris streams. The result is termed a meteor shower. Usually it's more a weak drizzle when compared to a real rain shower, so don't be disappointed. It still can be however, quite lovely. Sixty meteors an hour is considered to be a very good shower. Ten to fifteen meteors per hour is more common. On extremely rare occasions a thousand or more meteors an hour may be seen; these are termed meteor storms.

Most visible meteors are about the size of a grain of sand; sometimes one the size of a grape hits the atmosphere, when it does a fireball as bright or brighter than Venus can result. Now and then a meteor may reach the surface of the Earth; if you hear a sonic boom from a meteor then a fall is likely.

During a meteor shower, if you mentally trace the path backwards, you will find that they radiate from a particular spot (called naturally, the radiant.) This is a trick of perspective; Meteors in a shower actually move parallel to each other. Consider railroad tracks vanishing into the distance. Meteor showers are all named for the location of the radiant, either the nearest star or after a whole constellation. Showers are always best viewed on a moonless night after 12AM. At that time, instead of having meteors catch up to the Earth, after midnight we are plowing head-on into the stream.



*The radiant plotted on a chart*

For dates of the best meteor showers you should consult the club calendar page.

Meteors can and do appear at any time and from any direction and are not associated with any named shower; such meteors are termed sporadic. Once or twice an hour you will see a sporadic meteor.

**Eclipses:** Eclipses are fun events that happen all too rarely; they come in two different flavors: Solar and Lunar.

The Solar eclipse is the most dramatic; the Moon passes directly between the Sun and the observer temporarily causing darkness to fall. The Moon's shadow is quite small by the time it reaches Earth, only about 100 miles wide but the track can be thousands of miles long. A Solar eclipse is quite brief lasting just a few minutes at best.

**NEVER** look at the Sun with the naked eye. There are certain commercial products that allow you to do so safely, #14 welding glass being the most commonly available. **NEVER** use a homemade product to view the Sun. If you happen to own a telescope with a screw on eyepiece filter – throw the filter away! They are notoriously unsafe. There are various safe methods of viewing the Sun **indirectly** that can be performed by the do-it-yourself person. Eyepiece projection and pinhole cameras for example. If you are interested, you can check out the NASA eclipse website for details.

Lunar eclipses are less dramatic, but are visible over an entire hemisphere. These eclipses are caused by the Earth's shadow falling on the Moon. Compared with Solar eclipses, Lunar ones are quite leisurely, lasting a few hours from start to finish. Unlike their Solar cousins, Lunar eclipses are perfectly safe to watch with the naked eye – stare all you want too!

**Messier objects:** A couple of centuries ago a man named Charles Messier passed his time discovering comets. Time and again he was fooled by fuzzy objects in the sky which looked like comets initially, but which turned out not to be. This irritated him. He made a list of 110 objects for future reference so he and others would not be fooled again. Nowadays he is remembered for the list he made which turned out to be an honor roll for the most magnificent objects in the sky – his comets were mostly forgotten.

To be best appreciated, a telescope is required to view a Messier object; a few are visible (barely) to the naked eye, all are visible in a large pair of binoculars albeit with some difficulty.

M45 (the 45<sup>th</sup> entry on Messier's list) is the simplest to find; these are the famous Pleiades, located in the constellation Taurus. The Pleiades are a fine cluster of stars, six of which are easily visible to the naked eye. Dozens more stars are visible in binoculars. M31 is the famous Andromeda galaxy, while M42 is the equally famous Orion Nebula – both are visible to the naked eye as well.

If you are interested in tracking Messier objects down, lists and other tips are widely available on the internet.

A couple of items on Messier's list are missing. Rather jokingly it is often said they must really have been comets! A more likely explanation is they are transcription errors in the coordinates.