

The following should provide you with information and links about:

1. The sky and how it moves
2. Things that amateur astronomers frequently like to observe
3. Observing tips
4. Recording your observations
5. Comments on telescopes
6. Links for additional information
7. Constellations and stars
8. Glossary of astronomical terms
9. Amateur astronomer's tools
10. Recommended books

## 1. The sky and how it moves

**Size of the universe:** <https://www.youtube.com/watch?v=uaGEjrADGPA> . and <https://www.youtube.com/watch?v=GCTuirkcRwo>

**Longitude and latitude finder:** <https://www.latlong.net>

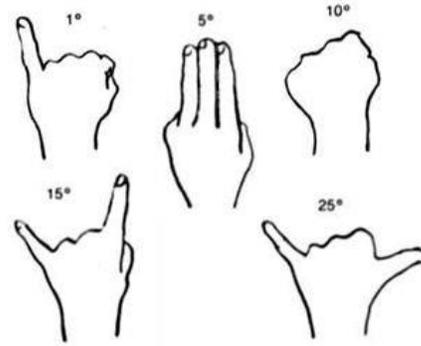
Part of knowing what is up in the sky is knowing where you are on Earth. In the Location field, enter the location of the place where you will be observing, e.g. [Charlottesville, Virginia, USA]. See resulting latitude, longitude and map of Charlottesville. Latitude 38.029305, longitude -78.476677 (Sprint Pavilion). This is accurate enough for your purposes. However, if you are a stickler for detail, click and drag the map to show where you live, click on that spot and read the latitude and longitude for that location. E.g., McCormick Observatory, between main observatory and the "doghouse", 38.032825, -78.522569. Enter your latitude and longitude into the location fields in *Stellarium* and *Heavens-Above.com*.

**Mapping the Sky.** As the surface of the earth is mapped with longitude and latitude, the sky is mapped with Right Ascension (RA) and Declination (Dec).

Declination is a close match to latitude. It is measured in degrees, arc-minutes and arc-seconds, with zero degrees at the celestial equator, +90° at the north celestial pole (NCP), and -90° at the south celestial pole (SCP). If the axis of the earth were extended to the celestial sphere, it would intersect at the NCP and SCP. If the earth's equator were extended outward to the celestial sphere, it would intersect at the celestial equator.

Longitude is also measured in degrees, arc-minutes and arc-seconds from zero at the Prime Meridian, to +180° in an easterly direction and to -180° in a westerly direction. But Right Ascension is measured in hours, minutes and seconds all the way around the sky from 0 hours to 23 hours, 59 minutes, 59.99... seconds. These are units of time, not of arc. Where on star charts the line of zero RA is located is more complicated than this memo permits. Learning this subject provides interesting review of astronomy, navigation, history, royal observatories, politics and trade.

**Measuring the Sky.** From time to time you will want to tell someone the location of an interesting object. It helps to have a convenient reference of degrees of arc. E.g., "There are a pair of colliding galaxies about 3-1/2 degrees below the star at the end of the Big Dipper Handle." Now, how do you and your guest measure 3-1/2 degrees in the real sky? A hand held up at arm's length provides a useful approximation.



<http://www.fortworthastro.com/beginner1.html>.

This works even for children with small hands, because their arms are shorter.

**Stellarium** planetarium program. See Appendix A, at end of this document. I recommend installing Stellarium on your computer. It replaces the need for many printed charts, graphs and catalogs.

**Stellarium program download:** <http://www.stellarium.org/>. At top of the web page are icons for various Stellarium operating systems, and for the PDF of the current User Guide. Scroll down the page and see System Requirements in the center column. Assuming your computer meets the system requirements, click on the icon at top of page that agrees with your operating system. Follow on-line instructions.

**Other planetarium programs:** *Carte du Ciel* is free: <https://sourceforge.net/projects/skychart/>. I have no experience with *Carte du Ciel*. *TheSkyX* and *Starry Night Pro* cost money (cost depending on version). Be sure to confirm compatibility with your operating system.

**Stellarium program usage.** See Appendix A, at bottom of this document.

**Stellarium User Guides** (match version with your version of Stellarium):

<https://sourceforge.net/projects/stellarium/files/Stellarium-user-guide/>

Don't worry about having to learn all this. If you have learned the key strokes to click and drag the sky around, to search for an object, to change the date and time, to select and de-select an object, to zoom and un-zoom, then you have what you need for 90% to 95% of your use of the program.

**Planispheres.** If you prefer not to get involved with the *Stellarium* program, an alternative is a planisphere. There is probably at least one model for sale at Barnes & Noble Bookstore. They are also often for sale in the lobby of the McCormick Observatory, which has open house on 1st and 3rd Fridays each month (But I can't say for sure that they are there now). Many models are available on line at [https://www.amazon.com/s/ref=nb\\_sb\\_ss\\_c\\_1\\_12?url=search-alias%3Daps&field-keywords=planispheres&srefix=Planispheres%2Caps%2C179&crd=SHUP4LXV5GLH](https://www.amazon.com/s/ref=nb_sb_ss_c_1_12?url=search-alias%3Daps&field-keywords=planispheres&srefix=Planispheres%2Caps%2C179&crd=SHUP4LXV5GLH). There is a free download available at <https://in-the-sky.org/planisphere/> which you can download, print, cut out and assemble, along with instructions.

If buying a planisphere, get one that is designed for 40 degrees north latitude, or a range that includes 38 degrees north latitude, which is where we are. You might want to hold off on buying a planisphere

until you can try out a couple of models. The tricky part of using a planisphere in the field will be reading it with a dim red LED flashlight. Red light should interfere with night vision less than white light (and especially blue-white of normal LED flashlights). But reading red light bounced off a white background star chart may or may not be more tolerable than trying to read smaller print and finer lines on a black background chart. I suggest you try before you buy.

Meanwhile, the free download, even without coordinate lines on acetate film, would be good for familiarizing yourself with what to expect from one of these.

Web page: **Heavens-Above.com**: <https://www.heavens-above.com/main.aspx?lat=38.0293&lng=-78.4767&loc=Charlottesville&alt=143&tz=EST>. Click second menu item on left side to change your observing location. *Heavens-Above* presents transient events, like satellite fly-overs, in addition to basic sky movement. Until you begin using a telescope to track satellites, increasing the accuracy of your location from Charlottesville to your nearby observing location is probably not justified. I recommend using the Charlottesville location for now. Click on the many subjects and see what they show you.

## 2. Things amateur astronomers frequently like to observe

### The Moon.

**Map of the Moon.** <http://fullmoonatlas.com/>. A question for you and your telescope is, which of the lunar features can you see?

**Map of the Moon, with discussions,** [http://www.cityastronomy.com/Moonbook\\_3v5.pdf](http://www.cityastronomy.com/Moonbook_3v5.pdf)

This discusses how features were formed.

**Lunar libration.** <https://www.youtube.com/watch?v=ixroBOCm8M8>. This a year long record of what the moon looked like from earth. Notice in the corners of the screen the diagrams of where the moon is in its rotation, orbit and tilt. The center view of the moon, oscillating, rocking enlarging and shrinking are a result of gravitational tidal lock and the movements shown in the screen corners.

**Creation of the Moon.** <https://www.youtube.com/watch?v=WGTBJHFNywI>. Touches on history of the question of how the Moon came to be. (Not NASA. Has commercial interruptions by my ISP. Click through ads and keep going.)

**How the Moon got its craters.** <https://www.youtube.com/watch?v=UIKmSQqp8wY>. Current thinking, as supported by radioactive dating of samples returned by Apollo missions.

**Planets.** [https://en.wikipedia.org/wiki/Main\\_Page](https://en.wikipedia.org/wiki/Main_Page). Search for Mercury, Venus, Mars, Jupiter, Saturn, Uranus and Neptune. Pluto is officially a "Minor Planet". Sources for location of planets in the sky are:

1. Computer planetarium program: e.g., *Stellarium* (free), *TheSkyX* (\$\$)
2. Tablet or cell phone planetarium app: e.g., *SkySafari* (\$)
3. Center page of *Astronomy* and *Sky & Telescope* magazines, and annual insert in January edition of *S&T*.

## Deep Sky Objects (DSOs)

**Globular clusters.** Clusters of from several thousand to several hundred thousand stars, close enough to be gravitationally bound to the group, but far enough apart to not crash into each other. Visually impressive in that the stars are so dense that you can't see through the group. Brightest and most easily found of the DSOs. Many are in Charles Messier's List (below). "M13" is a good example. [https://en.wikipedia.org/wiki/Messier\\_13](https://en.wikipedia.org/wiki/Messier_13).

**Open clusters.** Groups of stars, scattered far enough apart that observers can see through them. The Pleiades (Messier 45) is a good example of a naked eye open cluster. <https://en.wikipedia.org/wiki/Pleiades>.

**Planetary nebulae.** Remnants of dying stars. They resemble planets in that the shell of gas cast off by the star in its late stage of life appeared spherical and possibly planet like in early telescopes. Messier object M57 is a good example. [https://en.wikipedia.org/wiki/Ring\\_Nebula](https://en.wikipedia.org/wiki/Ring_Nebula).

**Nebulae.** Greek for "clouds." In space these are vast clouds of microscopic dust, illuminated by nearby stars (reflection nebulae), or gas, made fluorescent by nearby stars (emission nebulae). Messier object M42, aka "Orion Nebula" is a good example of a combined reflection and emission nebulae. This is visible in the winter sky. [https://en.wikipedia.org/wiki/Orion\\_Nebula](https://en.wikipedia.org/wiki/Orion_Nebula).

**Galaxies.** These are the "dim fuzzies" that amateurs enjoy when the sky is dark enough and the telescope is large enough. A notable exception is the Andromeda Galaxy (Messier M31). This galaxy is near enough (2.5 million light years away, MLY) to be seen naked eye in very dark and clear night skies. The outer arms of the galaxy are 6X the diameter of the moon, but are so dim as to not be seen except with a 16" diameter mirror or larger. Simple binoculars reveal the core which is about the diameter of the moon. [https://en.wikipedia.org/wiki/Andromeda\\_Galaxy](https://en.wikipedia.org/wiki/Andromeda_Galaxy).

**List of Messier Objects.** [https://en.wikipedia.org/wiki/List\\_of\\_Messier\\_objects](https://en.wikipedia.org/wiki/List_of_Messier_objects).

**List of Messier Objects, by season:** <http://www.messier.seds.org/xtra/similar/dataRASC.html>.

**Charles Messier.** [https://en.wikipedia.org/wiki/Charles\\_Messier](https://en.wikipedia.org/wiki/Charles_Messier).

### 3. **Observing Tips:**

1. "Seeing" in astronomy refers to the thermal stability of the air. Different air densities caused by thermal currents in the air will cause light to be refracted on its way from space down to you. This is what makes stars twinkle. This may be aesthetically pleasing to look at naked eye, but it messes up telescope viewing by making it impossible to get sharp focus. Seeing is poorest near to horizon and in early evening after sunset. Improve your observing by selecting objects when they are high in the sky, by observing after midnight and by not observing the night after a cool weather front has passed.
2. "Night vision" refers to a person's ability to see dimly lit objects. When you first step from a well-lighted indoor environment out into the dark night, you will have difficulty seeing objects around you, and the sky will look dark without stars. As time passes, you will be able to see

more stars. Depending on your age, complete “dark adaptation” can take from 5 to 15 minutes. Expect your vision to improve as the night progresses.

3. “Averted vision” means looking slightly to one side, above or below an object. Your eye has rod and cone photoreceptors. Cones are sensitive to bright colored light and rods are sensitive to dim light, but not to color. The largest concentration of cones is in the macula (central vision). By looking *around* the object instead of directly *at* it, light from a dim object will fall on rods, and be more visible than if you look straight at it and light falls on cones. If an object is very dim, try moving your sight around and over the object in a figure 8.
4. Lightly tap the scope to cause the objects in the field of view to move slightly. A really dim fuzzy patch of light is more noticeable if it is moving back and forth.
5. Ask yourself questions about the object being observed. This will help you learn what your telescope is capable of showing, and will help improve your observing technique.
  - a. All objects. What telescope aperture and focal length? What eyepiece and focal length? What magnification? How is the seeing? How is the transparency? At what altitude up from the horizon? Is moonlight interfering with deep sky objects? What is the official brightness, size and distance of the object?
  - b. The Moon. What phase? Are you looking along the terminator? What are names of seas, craters and mountains in the field of view? Can you make out any minor features like scarps, rilles or walls? How much visual flutter is being caused by seeing (thermal currents in the air)?
  - c. Planet. Is there a phase (crescent or gibbous)? Color? Phase? Waxing or waning? Can you see any surface detail? How many moons?
  - d. Saturn. How much ring tilt? Can you see ring shadow on the surface?
  - e. Open star cluster. Are stars similar brightness or does brightness vary a lot? About how many bright, medium and dim stars are there? Star color? Are there any unusually bright or colored stars nearby to help provide a unique signature to this object?
  - f. Globular cluster. Are stars spread evenly across the cluster, or is there a strong concentration of stars in the center? For the apparent size, do the stars seem coarse or fine? Are there nearby marker stars?
  - g. Planetary nebula. How round is it? Is it uniform visual density or does it appear ring-like? Is the edge even (gradual expansion of the star’s shell) or rough and hazy (violent explosion of the star).
  - h. Galaxy. Spiral, elliptical, edge-on or irregular? If spiral, can you see any of the spiral arms? Are other galaxies nearby?
  - i. Comet. Early on, as a comet is moving from outer solar system to inner solar system, the core will appear as a point, dimmer than most stars.

#### 4. **Recording your observations.**

A suggested *Observation Log* form is in Appendix B. Print copies and use to record your equipment, conditions, and observation for each object. Use **Observing tips**, paragraph 5, above, as a guide for what information you might include on your forms. Keep in a ring binder for later reference. Also, this can be kind of cool to show to your friends.

## 5. Comments on telescopes.

**How to choose your first telescope.** Enter “Choosing your first telescope” into a search engine field to see a large variety of latest information.

Also, see Chapter 5 in *NightWatch* (see Books, below).

1. The smart thing to do is not buy a scope. At least until after you have had the opportunity to observe through the several types and sizes, and discuss pros and cons with their owners. Also, it is important to consider what you want to do with your scope (we can talk more about this later).
2. Telescopes with larger primary mirrors and objective lenses capture more photons, and therefore can see dimmer objects in the night sky. While working with a telescope 4” and smaller, observe brighter objects (moon, planets, star clusters and brighter nebulae). Galaxies are dim. You might be able to see the core of a galaxy, but not much more than that.
3. Telescopes with larger primary mirrors and objective lenses offer better resolution than smaller diameter telescopes. E.g., in a smaller diameter telescope Mars will appear to be a reddish blob (which it frequently does anyway for reason of poor seeing). In a larger telescope, one might be able to resolve the light and dark patterns of the surface and see ice at the polar cap (if seeing permits).
4. Telescopes with longer focal lengths (1500 – 2500 mm) provide more magnification than telescopes with short focal lengths (600 – 1000 mm), using the same eyepiece.
5. Telescope prices go up exponentially with size and with quality (some reflector mirrors are better than others, and some refractor lenses are better (or more) than others).
6. The “schlep factor” goes up with the mirror or lens diameter. If you are thinking about buying a telescope:
  - a. How much weight can you carry? Judge by the weight of the disassembled components. E.g., for a simple Dobsonian reflector, how much does the base weigh and how much does the tube weigh.
  - b. How big an object can you fit into your car? This assumes you will want to take to a club star party or darker site.
  - c. How much storage room is available in your house or apartment?

### **Suggestions for setting up a telescope.**

1. Choose a place you can see to 30 degrees above the southern horizon (with arms out stretched, 30 degrees is about two times the distance between your thumb and first finger, when stretched wide apart.)
2. Choose a location from which you can see Polaris in the north. This is “nice to have” if your scope will not need polar alignment. It is necessary if your scope has an equatorial axis that must be pointed at the North Celestial Pole (NCP), which is close to Polaris (the North Star). This is not necessary if you use a recent, computer guided telescope that can be polar aligned when mounted in the altitude-azimuth position, with the tube level and pointed north.
3. If you use a magnetic compass to find north, you should correct for magnetic deviation (aka, magnetic declination). In the Charlottesville area, the north end of the compass needle or disk will point about 9 degrees west (on the left side) of true north. Magnetic declination of other places can be found at [www.ngdc.noaa.gov/geomag-web/](http://www.ngdc.noaa.gov/geomag-web/). Click on “Magnetic Calculators” in the left column. The compass on a cell phone or GPS will indicate true north. My iPhone also indicates my latitude and longitude.
4. Don’t set up on a deck. Minor deflections in the deck boards are greatly magnified in the telescope field of view (FOV).

5. Avoid setting up in a location where you will be observing over a roof or large paved area. These will be casting off thermal currents in the early evening. It would be better if you could set up overlooking a grassy field.
6. Choose a place where you won't be exposed to street lights or your neighbor's security lights.
7. If setting up a Dobsonian scope (with a flat base) try to set up on firm ground, not on long springy grass. (Mow the grass, and or lay down some heavy concrete paver stones or slate). Use shims or wedges under the feet of the ground board to make the ground board approximately level.
8. If setting up a tripod mounted scope, extend or retract one or more legs so that the top plate of the tripod is level.

### Telescope terms and calculations.

1. Basic information about any telescope:
  - a. Aperture. This is the diameter of the primary lens or mirror. (Inches or millimeters)
  - b. Focal length. This the distance from the lens or mirror to the focal plane, where an object at infinity will be focused. (Inches or mm)
  - c. Focal ratio, f/. The ratio of focal length to diameter.  $f/ = (\text{focal length}) / (\text{aperture})$ . Remember to use the same units in the numerator and the denominator.
2. Basic information about any eyepiece:
  - a. Focal length. The distance inside the eyepiece from the lens to the focal plane. (mm)
  - b. Field of View (FOV). The apparent width or diameter of what you can see while looking into the eyepiece. (Degrees).  $65^\circ$  FOV is pretty basic; price goes up for wider FOV.
  - c. Eye relief. The distance your eye can be from the lens. Large eye relief is important if you need to wear glasses when observing.
3. Basic dimensions:
  - a. Full circle = 360 degrees
  - b. 1 arc-minute =  $1/60$  degree
  - c. 1-arc-second =  $1/60$  arc-minute =  $1/3600$  degree.
  - d. True field of view (FOV or TFOV). The diameter of an object as seen from Earth, without benefit of telescope. E.g., the moon is about  $\frac{1}{2}$  a degree or 30 arc-minutes.
4. Calculations: (You probably don't need the calculations now, but here they are for if and when you do need them.)
  - a. Magnification or power. How much larger an object appears when viewed through the telescope and eyepiece. Magnification,  $M = (\text{telescope focal length} / \text{eyepiece field of view})$ .
  - b. True field of view (TFOV). The size (as seen without telescope) of the sky that appears in the eyepiece.  $TFOV = \text{Eyepiece FOV} / \text{Magnification}$ . Useful for determining which stars on a star chart you should expect to appear in your low power finder scope.
  - c. Apparent size. How large an object appears in the eyepiece. True size x magnification.
5. Example. Orion Nebula observed through 8" f/10 telescope, with 32 mm eyepiece.
  - a. Telescope focal length = 8 inches x 10 x 25.4 mm per inch = 2032 millimeters
  - b. Magnification = (telescope FL / eyepiece FL) =  $2032 / 32 = 63.5x$  power.
  - c. Orion Nebula is listed as being 65 x 60 arc-minutes (65' x 60').
  - d. Apparent size of the Orion Nebula when viewed in the eyepiece will be (65'x63.5) x (60'x63.5) = 4128' x 3810', or  $68^\circ \times 64^\circ$ . (This can nearly fill up your field of view.)

## 6. Links for additional information.

1. Charlottesville Astronomical Society, <http://cvilleastro.com/>. Click on their “Astro Links” tab for many additional links.
2. The Astronomical League (an association of astronomy clubs and members), <https://www.astroleague.org/>.
  - a. Additional links are on the left side of the web page.
  - b. Upcoming star parties, lectures and other events are listed down the right side of the page.
  - c. Of particular interest to many novices are the observing programs and certificates that are offered. Click on “Observe” at top pf web page, then on “Observing Programs.” Many novices like the Messier program as a way of learning the sky, and the Lunar and Lunar II programs, given the moon is available so much of the time. Consider participating in one of these as you develop in amateur astronomy.
3. *Introduction to Astronomy*, a 6 or 7 session evening course offered by Open Doors Personal Enrichment Program (about \$60) at Albemarle High School. Has been offered twice a year. <https://www.digitalsignup.com/Home.aspx?SoftwareId=+ev50Ymj5avTv1JYXVtHRQ==>. Under non-credit courses, click on “Personal Enrichment”. Down the page find course 6001, *Introduction to Astronomy*.
4. Heavens-Above, <https://www.heavens-above.com/main.aspx?lat=38.0293&lng=-78.4767&loc=Charlottesville&alt=143&tz=EST>. . Lists interesting events in the sky (e.g., meteor showers, comets, satellite fly-overs)
5. Astronomy Picture of the Day (APOD), <https://apod.nasa.gov/apod/astropix.html> . In the band of links near the bottom of the page, click on the “≤” symbol for the previous day’s picture. Or click on “Archive” for the complete library, back to June 16, 1995.
6. Latitude and longitude finder: <https://www.latlong.net>.
7. US Naval Observatory Sun & Moon Rise & Set and Civil, Nautical and Astronomical Twilight, [http://aa.usno.navy.mil/data/docs/RS\\_OneYear.php](http://aa.usno.navy.mil/data/docs/RS_OneYear.php) The end of astronomical twilight marks when the sky will be about as dark as it will get. This is important if you are trying to observe dim objects such as some nebulae and extended arms of galaxies.

## 7. Constellations and Stars

1. Amateur astronomers should learn the constellations because these are like roadmaps in the sky you can use to locate interesting objects to observe. When you first learn about a star cluster or galaxy of interest, note where it is in the constellation, so you can come back to it easily on a later date. Constellations are sets of stars to which people have assigned names and associated myths, legends and stories. They may be represented by sumptuous renaissance illustrations or by stick figures connecting some of the stars in the set. Different cultures have different constellations (which may or may not be the same arrangement of stars). There are 88 constellations in sky. There are 12 constellations around the ecliptic (the path the sun gradually moves in the sky as seasons change). These are known as the Zodiac, and are of particular interest to astrologers. Frequently amateur astronomers will refer to only part of the complete constellation. E.g., Ursa Major (the big bear) has about 18 stars in the usual stick figure that represents that constellation. However, we frequently refer to the 7 brightest stars of Ursa Major as “the big dipper”. The big dipper is not a constellation; it is an “asterism,” i.e., simply an arrangement of stars. Similarly, in the constellation Sagittarius, the bright stars resemble a stick figure of a “teapot.” There is a bright star cloud of our Milky Way galaxy, just above the spout of the teapot. The whole scene looks like steam coming out of the spout of a hot teapot.

2. Star names.
  - a. Stars have proper names. Many of these are of Arabic origin because the Arabs did such a thorough job of naming and recording names of stars.
  - b. Bayer. They also are named for the constellation in which they appear, with the brightest star being the "alpha" star, the second brightest star being the "beta" star, and so on. The name of the constellation is in the Latin possessive case. This system was developed by German astronomer, Johann Bayer, and published in his *Uranometria*, in 1603. Betelgeuse (Arabic) is also *alpha Orionis* (Bayer) because it is the brightest star in the Orion constellation. (Alpha Orionis means "alpha of Orion".)
  - c. Flamsteed. There are a lot more stars inside the boundary of a constellation than simply the bright ones. Also, there is the matter of who to locate them. In the first star catalog of star positions published by the Royal Astronomer John Flamsteed, stars within constellation boundaries were numbered according to their "right ascension", i.e., number 1 being the farthest west and the highest number being the star farthest east. Betelgeuse is also named *58 Orion*, being the 58<sup>th</sup> star eastward inside the constellation boundary.

8. **Glossary of astronomical terms.** <http://www.skyandtelescope.com/astronomy-terms/>

9. **Amateur astronomer's tools.**

1. Red or red & white LED flashlight, preferably with a brightness adjustment. Useful for reading star charts without compromising your night vision. At a star party, your fellow astronomers will appreciate you *not* using a white flashlight! As a temporary measure, cover a white flashlight with about 4 or 5 layers of clear red acetate. Rigel Systems "Skylite" is a good example. <https://agenaastro.com/agena-led-dual-beam-astronomy-flashlight.html>
2. Star charts, planisphere or computer program for planning a future observing session.
3. Star charts, planisphere or smart phone app to use at night at the scope. (Computer screens near the scope can mess up your night vision.) Sky Publishing has a goodly number of these. I like *Sky & Telescope's Pocket Sky Atlas*, and *S&T's Messier Card*. <http://www.shopatsky.com/>. A minor problem with the *Sky Atlas* is that galaxies are printed in red ink; this becomes indistinguishable from the rest of the page when viewed with a red flashlight. Mark galaxies of interest for your next session with a Post-It note. Don't make notes in red ink if you expect to read them with a red flashlight.
4. If your scope requires polar alignment, a bubble level and a magnetic compass, or a smart phone with compass and level apps.
5. Binoculars. The Moon and some of the brighter deep sky objects are visible through binoculars. "10x50" means the binoculars are 10X power and that the objective lenses are 50 mm diameter. Higher power binoculars tend to have a shaky view, and should be braced against a solid object. Bigger binoculars can get heavy and should be supported by a monopod, bipod or tripod. Try looking at the Milky Way near the horizon, and gradually browsing upward along the path of stars.
6. Mosquito repellent in summer.
7. Warm clothes in winter. A clear overhead sky will suck away a lot of heat from surfaces facing upward. Dress for 10°F to 15°F degrees colder than the ambient temperature. Cool wet grass can suck more heat out of your shoes or boots than frozen hard dirt or gravel. Wear double socks or use toe warmers.

8. A bag or satchel to carry charts, flashlights, spare eyepieces, etc.
9. A checklist to itemize all the things you want to take to the field. Check things off as you load them.

#### **10. Recommended Books**

- *365 Starry Nights*, by Chet Raymo. This has clear and simple illustrations and explanations of the solar system, stars, nebulae, galaxies and constellations. Subject matter is arranged seasonally, January through December. For each night of the year there are a few paragraphs and an illustration, with two to four nights per page.
- *NightWatch, A Practical Guide to Viewing the Universe*, by Terence Dickinson. A tour de force of nearly everything the novice might want to know, from equipment to where the interesting objects are in the sky.

#### **Closing:**

This is a lot of information. I don't want to overwhelm you, but this will give you a head start for when we do get together for mentoring or an observing session. If you have any questions, please email me!

## Appendix A - Stellarium

**Stellarium program download:** <http://www.stellarium.org/>. At top of the web page are icons for various Stellarium operating systems, and for the PDF of the current User Guide. Scroll down the page and see System Requirements in the center column. Assuming your computer meets the system requirements, click on the icon at top of page that agrees with your operating system. Follow on-line instructions.

**Stellarium User Guides** (match version with your version of Stellarium):

<https://sourceforge.net/projects/stellarium/files/Stellarium-user-guide/>

Don't worry about having to learn all this. If you have learned the key strokes to click and drag the sky around, to search for an object, to change the date and time, to select and de-select an object, to zoom and un-zoom, then you have what you need for 90% to 95% of your use of the program.

**Stellarium program usage.** When this first opens, it will appear that you are standing in a field in Guereins, France, looking south. Move your cursor to the lower left side of the screen to see six window icons.

1. Location. Click on this to specify where in the world you are located. Either:
  - a. Scroll down the list of cities and choose Charlottesville, United States (or next nearby large city, i.e., Washington DC, United States), or...
  - b. Type, e.g., "Free Union" into the Name/City field and enter the latitude and longitude. My guess is that Free Union altitude is about 500 meters above sea level (altitude accuracy is not so important). Click on <Add to List>, and check the box "Use current location as default."
  - c. Click on X at top right to close any window.
2. Date/Time Window. Click to change the date and time for the sky. *Stellarium* default time is the system time for your computer. Hours are for a 24 hour clock, not a 12 hour clock. 10:00 pm is shown as 22:00:00. This feature is essential for planning a future observing session. You will want to know where in the sky to look for a target object. The sky appears to be rotating around us at a little bit more than one revolution per day. Therefore you will need to specify the date and time of your observing session in order to know whether or not that target object is up during your observing session. Conversely, you can spin the year, month, day and hour numbers until the target object is up, and plan on observing it at that time.
3. Sky Viewing and Options Window.
  - a. If you want to see the sky without atmosphere, then in the Sky tab, in the lower left, uncheck the box at "Atmosphere". Jupiter is bright enough to see with a small telescope in daylight, if you know where to look.
  - b. I like to see the compass bearings (NESW) along the horizon. In Markings tab, Celestial Sphere panel, left column, 2<sup>nd</sup> line from the bottom, check box for "Cardinal points" to show NESW.
  - c. I like the grassy field horizon for Guereins, France. It looks like some of the horse pastures in the Keswick area. If you want to see other horizons, open Landscape tab and click on locations in the left column.
  - d. Starlore tab has interesting information on astronomy in other cultures. No everyone uses the same star names and constellations that we do. Western is default.
4. Search window. This assumes you know the common name or catalog number of an object.
  - a. Open Date/Time window. Change hour to 23.

- b. Open Search window. Type in "Saturn" and hit enter key, or click on magnifying glass (search) icon.
  - c. *Stellarium* will change to night, and rotate the sky until Saturn is centered in the screen.
5. Navigating around the screen. Mac controls will be slightly different than Windows controls.
  - a. Click on the scenery and drag it left or right to change the direction you are looking. Use multiple clicks and drags to pull the scene all the way around.
  - b. Change the time to sometime at night, or make the atmosphere disappear. Click on a star to open text information in top left of your screen. Right click to make that text disappear.
  - c. Search for, or click on, Saturn. See text top left. Hit spacer bar to center the object in the screen. Hit the forward slash key (the one with the question mark) to zoom to a close up view of the object. Notice details, e.g., surface patterns, phase (sunlight illumination) and position of moons (all these things are accurate). If you want to observe Jupiter with your telescope, and know which of the four bright moons you are seeing, this feature of the program is a good way to identify them. Hit the back slash key (with vertical pipe) to un-zoom back to normal view. Gradual zoom and un-zoom can be had by pressing the up and down arrows on the number keyboard while holding down the Ctrl key in Windows, and I believe by holding down one of the four keys at bottom left of the Mac keyboard, but I forget exactly which one. (See #7, below)
6. Configuration Window. Skip this for now.
7. Help Window. Help tab. Here is where you can find all the key strokes that apply to your current version of *Stellarium* on your particular OS. There are a lot more key strokes here than you will need. I mentioned the few, most used key strokes above.

In addition to the Windows on the left side of the screen, there are a number of toggle icons along the bottom left of your screen. Let your cursor hover over each for a hint of what each does. Click on each to turn that feature on or off. (It would be good to work in a semi-dark work area, with screen intensity turned up. Some of the features on screen do not show up well, and if your work area is sunny, you may miss seeing them.)

**Appendix B - *Observation Log* follows on next page.**

# Observation Log

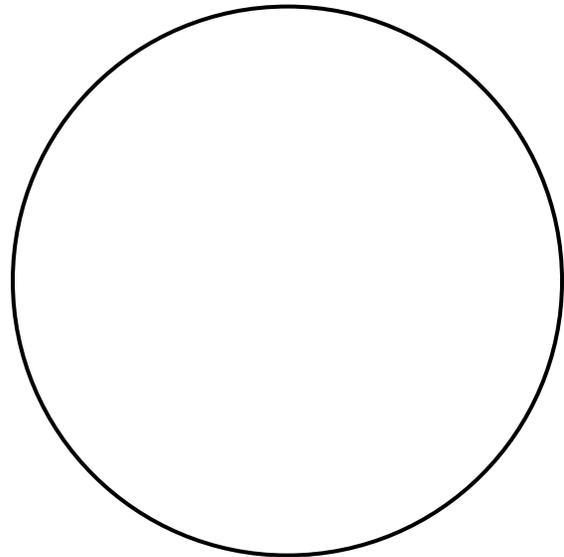
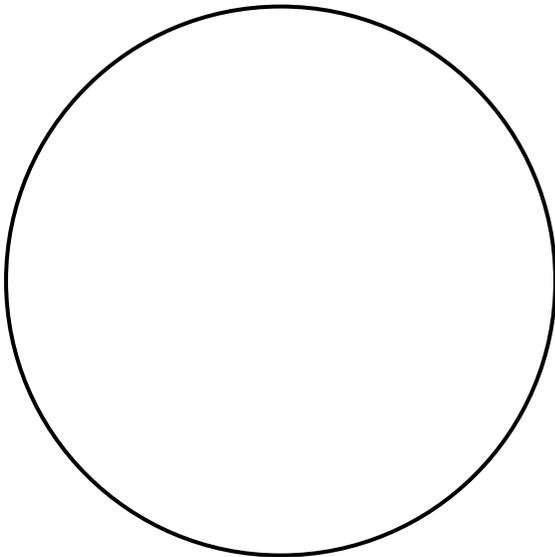
Observer \_\_\_\_\_  
Date \_\_\_\_\_  
Time \_\_\_\_\_  
Location \_\_\_\_\_  
Seeing [1(bad)-10(good)] \_\_\_\_\_

Object \_\_\_\_\_  
Constellation \_\_\_\_\_  
RA/Dec. \_\_\_\_\_  
Listed Magnitude \_\_\_\_\_ Listed Size \_\_\_\_\_  
Source \_\_\_\_\_  
Telescope/Binoculars \_\_\_\_\_  
Ocular(s) \_\_\_\_\_ Filter(s) \_\_\_\_\_  
Transparency [1(bad) – 5(good)] \_\_\_\_\_

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## Field Drawings

Low Power Magnification, FOV \_\_\_\_\_ High Power Magnification, FOV \_\_\_\_\_



## Description and Notes