

# Ranger Training in Astronomy 2015

This is an outline of topics and facts which I hope will stick with you when added to your general knowledge of the sky and astronomy. I will not be covering all of these in this session.

The big thing we want to promote is dark skies. The starry skies are a legacy that were once freely available to all. Now one must travel outside our cities. The larger the city, the farther one must travel. It is in places like this that we must preserve nature both on and in the Earth but our access to the beauty and knowledge of the heavens. It is our birthright. Cherish and protect it.

Bob Moler

## A) Constellations and stories

### 1) Asterisms and constellations

- a) The Big Dipper is the hind part of Ursa Major, the great bear
- b) The Little Dipper is Ursa Minor, the lesser bear
- c) The Sickle, front part of Leo the lion. Also called a backward question mark
- d) The Keystone is the central part of Hercules
- e) The Summer Triangle consists of three of the brightest stars in the summer sky
- f) The Northern Cross is part of Cygnus the swan
- g) The Teapot is part of Sagittarius the archer

### 2) Finding stars and constellations using the Big Dipper

- a) The stars at the front of the bowl point to Polaris
- b) Follow the arc of the handle of the Big Dipper to Arcturus in Boötes
- c) Straighten the arc to a spike to drive to Spica (pronounced spike-a) or Straighten the arc to speak to Spica (pronounced speak-a)
- d) Water leaking from the bottom of the bowl falls on Leo the lion's back

### 3) Constellation Stories. Also search [bobmoler.wordpress.com](http://bobmoler.wordpress.com), and check the list of articles in [ephemeris.bjmoler.org](http://ephemeris.bjmoler.org).

- a) Callisto and Arcas (Ursa Major and Boötes)
- b) How the Fisher Star (Ursa Major) brought summer to the Earth.
- c) Corvus the crow, Crater the cup and Hydra the water snake on why crows are black.

## B) Astronomy rules of thumb

- 1) All apparent distances in the sky are angles.

- 2) Angles measured at your arm's length:
  - a) Width of little finger =  $1^\circ$
  - b) Three finger widths =  $3^\circ$
  - c) Width of your fist =  $10^\circ$
  - d) Spread of your hand little finger to index finger =  $15^\circ$
  - e) Span of your hand outstretched little finger to thumb =  $25^\circ$
- 3) Altitude of Polaris the north star equals your latitude (approximately).
  - a) At the Sleeping Bear Dunes it's about  $45^\circ$ .

### C) Moon and Planets

#### 1) The Moon

- a) Watch the phase and position of the moon change from night to night.
  1. The Moon is illuminated by the Sun. The unilluminated part of the Moon is simply its night side.
  2. The Moon's phases can be illustrated by holding a ball in the sunlight and turning around with it.
  3. For a few days before and after new moon the dark part of the moon is illuminated by the nearly full Earth in its sky. This is best seen in binoculars. The effect is called earthshine. The old, more poetic name is: Old moon in the new moon's arms.
- b) In the evening the Moon's phase waxes (grows fatter), and the moon moves eastward against the stars by about 13 degrees, 26 of its diameters a day. After full moon the phase wanes (grows thinner).
  1. The Moon moves about its diameter against the stars in an hour.
  2. On average the Moon rises and sets 50 minutes later each night. However that's only an average.
    - i. The Harvest Moon, (Nearest full moon to the autumnal equinox), September 27<sup>th</sup> in 2015. Difference in moonrise times is about 40 minutes. It can be less than 30. This is the Harvest Moon effect, which allowed farmers of old extra time to gather in their crops.
    - ii. The opposite effect occurs at the spring full moon, when the advance in moonrise times was an hour this year.
    - iii. This can vary from year to year.
  3. The summer full moon is low in the south, and the winter full moon is high in the south. The reason is that the Moon, when full is opposite the Sun in the sky and is

approximately where the Sun was 6 months ago in the opposite season.

2) Venus

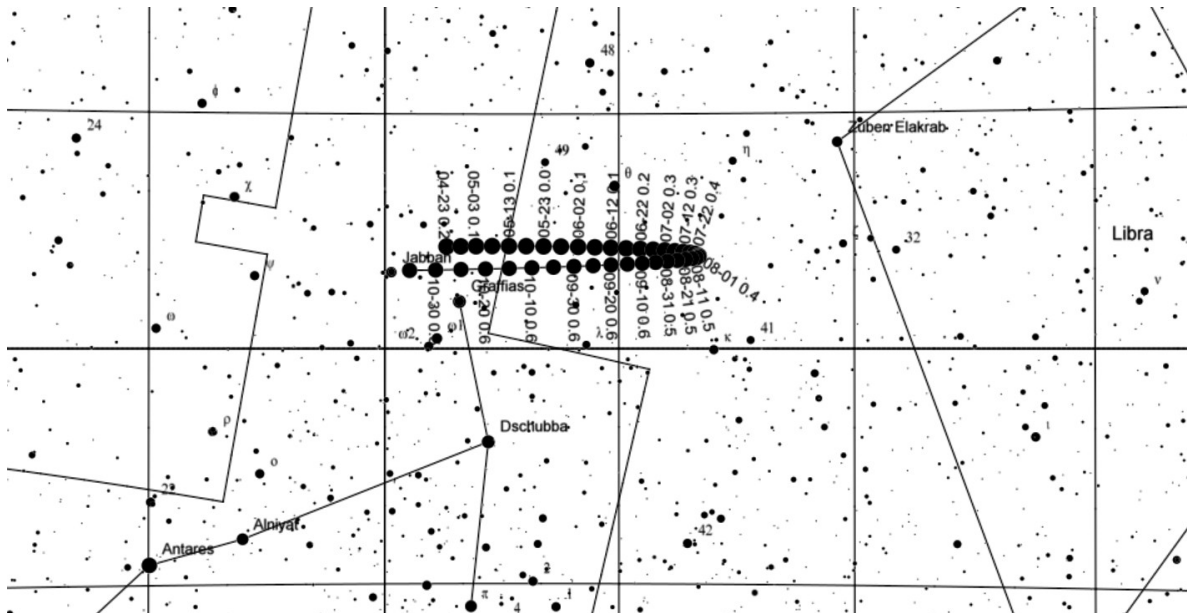
- a) Greatest elongation east of the Sun on June 6<sup>th</sup>. After that Venus will appear as a crescent in telescopes. After mid July the crescent should be visible in binoculars.
- b) Venus will be increasingly hard to spot in the evening sky after the end of June.
- c) Inferior conjunction with the Sun on August 15<sup>th</sup>. A week or so later Venus will appear in the morning sky just before sunrise.

3) Jupiter

- a) Will move eastward through the constellation of Leo this summer.
- b) Will be in conjunction with Venus June 30.
- c) Some of the moons can be seen in binoculars.
  - 1. The moons in order of distance from Jupiter: Io, Europa, Ganymede, and Callisto
- d) It will be lost in the bright evening twilight in mid July.

4) Saturn

- a) Rings visible in telescopes of at least 20 power.
- b) Small telescopes can also spot it's largest moon Titan.



- c) Saturn will be moving westward until late July and then reverse direction eastward. It will be moving between Libra on the west and Scorpius on the east.

D) Meteors and meteor showers

- 1) General facts

- a) Meteor showers occur when the Earth passes through debris left near the orbit of a periodic comet by its prior passes near the Sun. So they occur on about the same date every year.
  - b) Meteor showers are generally named for the constellation or star from which they appear to come.
  - c) While shower meteors appear to come from a particular point called the radiant, they will appear all over the sky.
  - d) Most meteors are drowned out by the bright moon.
  - e) One can generally see about five non-shower, or sporadic meteors an hour on a dark moonless night, especially near dawn.
  - f) A fireball is a meteor as bright as Venus, or bright enough for people to report it.
  - g) A bolide is a fireball that explodes.
- 2) Meteor showers May – December:
- a) Eta Aquariids (Near the Water Jar asterism of Aquarius, low in the southeast early morning) visible April 19 – May 28, peaks on May 6. Debris from Halley's comet on its way out from the inner solar system. Fairly active shower but the bright Moon will interfere with the peak night..
  - b) South Delta Aquariids (Southern part of Aquarius, low in the southeast early morning) visible July 12 – August 23, peaks on July 30. Poor shower and the Moon will interfere this year.
  - c) Perseids (Perseus) visible July 17 – August 24, peaks on August 13. Visible all night, but highest numbers will occur in the morning. Possible 100 meteors per hours at the peak! There's no moon this year, it's new moon!
  - d) Draconids (Draco's head) visible October 6-10, peaks on October 9. Rare shower: best seen in the evening. Can be spectacular some years. This ain't their year.
  - e) Orionids (Orion's club) visible October 2 – November 7, peaks on October 21. Debris from Halley's comet on its way in to the inner solar system. 15 meteors an hour tops, after midnight, but the Moon will be a problem.
  - f) Leonids (Head of Leo) visible November 6 – November 30, peaks on November 18. Every 33 years all heavens breaks loose. The last time was 1999. Otherwise maybe 20 per hour tops, after midnight. The Moon won't be a problem.
  - g) Geminids (Gemini) visible December 4-17, peaks December 14. Most active shower year in and year out. Too bad it's in December. Visible all night with up to 120 meteors an hour at peak. The Moon won't be a problem.

#### E) Sighting the International Space Station

- 1) There are distinct “seasons” where the ISS is visible either in the evening or morning.
- 2) Here are Internet locations where the ISS predictions can be seen. Note that the ISS is often listed as Zarya, the name of the first (Russian) module of the station placed in orbit.
  - a) <http://heavens-above.com>
  - b) <http://www.calsky.com> can display a calendar of events for a night.
  - c) <http://spaceweather.com/flybys/> enter your ZIP code
- 3) The ISS like many satellites moves generally from east to west. In the evening the ISS will usually disappear in the Earth's shadow before it reaches the eastern horizon.
- 4) Unrelated to the ISS are Iridium flares. Iridium is the name of a satellite phone company with nearly 90 satellites. They have flat antennas and when they catch the sun can produce a flash that can be seen. CalSky and Heavens-Above predict these too.

#### F) Sun and Aurorae or Northern Lights

- 1) The Sun
  - a) Trick question: What's the nearest star? Answer: The Sun.
    1. The next nearest star is the Alpha Centauri star system at 4.3 light years. If you want to get picky, it's Proxima Centauri, the red dwarf star part of that triple star system, invisible to the naked eye.
  - b) Sizes:
    1. The Sun is 100 times the diameter of the Earth
    2. One could put a million Earths inside the sun. ( $100^3$ )
    3. The Sun is 10 times the diameter of Jupiter.
  - c) Distances:
    1. The Sun is on average 93 million miles away or 150 million kilometers.
    2. The Earth's orbit is a slight ellipse. The Sun is about  $91\frac{1}{2}$  million miles away in early January and  $94\frac{1}{2}$  million miles away in early July.
    3. The Earth's seasons are caused by the tilt of the Earth's axis, not distance.
  - d) Sun facts:
    1. The Sun is 73% hydrogen, 25% helium,  $\frac{3}{4}\%$  oxygen,  $\frac{1}{4}\%$  Carbon, 1% other elements.
    2. The Sun does not produce energy by “burning” in a chemical sense. It's by thermonuclear fusion of hydrogen into helium.
    3. The Sun and the solar system is 4.567 billion years old. Dated by uranium decay in

zircons in carbonaceous chondrite meteorites.

4. The Sun has about 4-5 billion years to go before it runs out of hydrogen in its core and expands into a red giant star. It may swallow the Earth.
5. The part of the Sun we see is the photosphere (light sphere). Though it's sometimes called a surface, it's completely gaseous like the rest of the sun. It is approximately 10,000° F (5777 K), whereas the core is 30 million degrees F, or 15.7 million K.
6. Being a sphere the Sun doesn't rotate as a solid body. 25 days at the equator, and 30 days near the poles.
7. Telescopes with normal “white light” filters only see the photosphere with sunspots, faculae and granules.
  - i. Sunspots are cool areas in the photosphere caused by magnetic fields below.
  - ii. Sunspot numbers vary in a period of roughly 11 years. The last peak was in early 2014. The sunspot cycle has completely disappeared in the past. Look up Maunder Minimum.
  - iii. Faculae bright patches seen near sunspots. They are best seen when they are near the limb (edge) of the sun. They all to the sun's intensity and are the reason that the Sun puts out slightly more heat when there are more sunspots visible.
  - iv. Granules are the tops of convection cells that come up from below the photosphere. They are rarely seen due to the fact that they are only 600 miles in diameter and last for a few minutes at most. It takes a steady atmosphere to see them. The photosphere is the layer of gas within the Sun where the energy transport changes from convection to radiation.
8. The GTAS has a solar telescope with a hydrogen alpha filter that only transmits the emission of the element hydrogen in the red part of the spectrum. With it the layer of gas just above the photosphere is visible which can show detail even on a spotless Sun.
  - i. The chromosphere seems somewhat fuzzy, like a red lawn that needs cutting. These are spicules, projected up from the photosphere.
  - ii. Plages are bright patches, usually found near sunspots and are related to faculae seen on the photosphere in white light.
  - iii. Dark filaments seen on the face of the Sun and prominences off the edge of the Sun are clouds of hydrogen gas trapped in magnetic fields above the photosphere.
  - iv. Bright spots near sunspots that can appear for several minutes are called solar flares, which are explosions that put all the world's nuclear arsenals to shame. Appear and can eject prominences that can escape the sun Coronal Mass

Ejections (CMEs) that can, if aimed toward the Earth cause the northern lights.

9. The corona is the Sun's tenuous atmosphere of charged atoms that continually stream from the Sun. Once far enough from the sun to be invisible, it's called the solar wind.
  - i. The corona can only be seen from the Earth during a total solar eclipse. (The next total solar eclipse for the United States is August 21, 2017)
  - ii. It can be seen from space by blocking out the photosphere.

## 2) Northern Lights

- a) They are not easily predictable. They can be the result of an enhanced solar wind or a CME interacting with the Earth's magnetic field.
- b) Online information and predictions:
  1. <http://spaceweather.com/>. Shows the white light sun, plus other space weather and meteor events. Click on Subscribe on the red bar on top to get free emails of possible aurorae and other events sent to you. That one's free.
  2. <http://www.swpc.noaa.gov/>, the NOAA Space Weather Prediction Center. Tons of images of the Sun now, plus geomagnetic storm levels and predictions and links to much more information about the Sun and the Earth-Sun connection.

## G) Noctilucent clouds

- 1) These are rarely spotted south of 50° latitude in the summer months. The name means “night shining” clouds.
- 2) These can be seen overhead as the glow of twilight fades. They are white and seem to move rapidly.
- 3) They are very high to still catch sunlight as the twilight glow is fading. They seem to be about 50 miles altitude and made of ice crystals.
- 4) They are not well understood.

## H) Some Astronomical Misconceptions

- 1) The Moon and Sun only appear larger when near the horizon. It's an optical illusion. They are not.
- 2) Polaris is not the brightest star. It is, however, nearly stationary in the north.
- 3) The seasons are not caused by the change in Earth's distance from the Sun.
- 4) The Northern Lights are not caused by sunlight reflected off the polar cap.
- 5) The far side of the Moon is mistakenly called the Dark side. The dark side of the Moon is the night side, which every part of the Moon experiences every month for two weeks. Also

the far side of the Moon never experiences a lunar eclipse when the Earth cuts off sunlight to it. Plus at new moon the far side is closer to the Sun than the Earth is.

- 6) The Moon is not white but a dirty gray color. It's reflectance (albedo) of sunlight is only 13%.