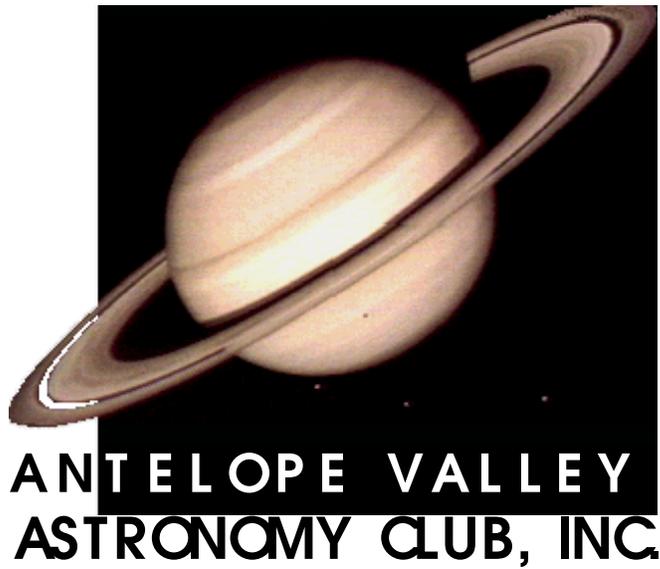


Introduction to the Night Sky - Part II



Antelope Valley Astronomy Club, Inc.

February 2003

Introduction to The Night Sky - Part II (Intermediate) (1 hour)

Outline:

- I. Constellation and Stars
 - Names
 - Magnitude Scale
- II. Finding your way in the sky
 - How to estimate angular separation
 - Right Ascension and Declination
 - How to use a Star Atlas
 - How to Star Hop
- III. Furthering Astronomical Skills
 - Learning how to See
 - Planets
 - Low Contrast Deep Sky Objects
 - Recording your observations
- IV. Astronomical League Observing Programs
 - Messier List
 - Lunar Club
 - Solar Observing
 - Planetary Observing
 - (Listing of Others)
- V. Star Party Question and Answers

HELP!

If you have an equipment problem, call any Club Officer at their phone numbers listed on your monthly newsletter and on the club website. **WE WANT TO HELP YOU** with your astronomy problem and give you the right answer that will help you enjoy the night sky, while keep the Club's equipment working well for the next member.

Antelope Valley Astronomy Club, Inc.
<http://www.avac.av.org/>

Magnitude Scale

The brightness of an object in the sky is called its magnitude. You'll encounter this term often.

The magnitude scale on which stars are rated has evolved from a convention first established by Ptolemy 2100 years ago and is now traditional. In his catalog of stars he classified their apparent magnitudes by rating the brightest star he could see as magnitude 1 and the faintest as magnitude 6. As this system evolved over the centuries, some stars were found to be brighter than magnitude 1; for example, Vega is magnitude 0, and Sirius is magnitude -1.4. The first peculiarity to note about the magnitude scale is that the **larger negative** magnitude a star (or any celestial object) has, the **brighter** it is; but the **larger positive** magnitude, the **fainter** the star.

Stars of first magnitude are 100 times brighter than stars of sixth magnitude; a difference of 5 magnitudes corresponds to a brightness ratio of 100. A difference of 1 magnitude then amounts to a brightness ratio of 2.512. This strange number pops up because $2.512 \times 2.512 \times 2.512 \times 2.512 \times 2.512 = 2.512^5 = 100$, another way of stating that a difference of five magnitudes equals a ratio of 100 in brightness.

Object	Visual Magnitude	
Sun	-26	Brighter
Moon	-13	
Iridium Flash* (at brightest possible)	-8	
Sirius	-1.4	
Vega	0	
Orion Nebula (M42)	+4	
Ring Nebula (M 57)	+9	
Typical Virgo Cluster galaxy	+9 to +10	
Faintest Messier object	+11.5	
Faintest stars observable by 8" SCT	+14	
Faintest stars observable by Hubble	+25	Dimmer

(*Check out <http://www.heavens-above.com> to find out about Iridium Flashes)

Constellations and Stars

The human mind has always attempted to fit patterns to complex arrangements of individual objects. Early man tried to impose order on the heavens by assigning names to perceived patterns of the brightest stars. The names not only depended upon an imagined shape made by 'connecting the dots', but also by the constellations in close proximity. An example can be when looking at the constellation Orion, The Hunter. One can imagine Orion with his arms and legs outstretched, three stars making up a belt, a sword dangling from the belt, and on a clear, dark night, even make out an arc of stars that represent Orion's shield. But just to the east of Orion and near his right foot, is the bright star Sirius. It takes more than a little imagination to see Orion's faithful dog at his feet, made up primarily by the two clearly visible stars in the constellation Canis Major. It takes a bit more imagination to see the rabbit Orion has slain in the constellation Lepus just to the south, below Orion's feet.



The constellation of Orion, The Hunter

Most of the 88 constellations visible to us throughout the year are derived from ancient mythology. Andromeda, Perseus, and Hercules are well known examples. We have maintained many of the ancient names to this day, and added new ones to fill in gaps. As our knowledge of the southern hemisphere skies increased during early ocean voyages of exploration, many new constellations were added. Today, professional astronomers have rigorously

established the boundaries between the constellations. They are used for convenience only, to help scientists segment the sky into comprehensible, meaningful sections.

When attempting to learn the constellations, try taking the approach of learning one at a time, and learning each one well before moving on to the next. Going out with a star chart or a planisphere for several nights in a row will give you confidence that you can translate the little dots on the charts to the vastness of the constellations in the night sky. Each month the sky the sky "advances" 30 degrees to the west*, with the new season's constellations rising earlier and earlier. From our latitude, you will see Orion highest overhead at 8:00 pm on February 1, 60 degrees above the western horizon at 8:00 pm on March 1, only 30 degrees above the western horizon at 8:00 pm on April 1, and setting in the western sunset on May 1.

*Note: $30 \text{ degrees/month} \times [12 \text{ months/year}] = 360 \text{ degrees per year}$

Sky Measures

Hold your fist at arm's length and sight past it with one eye. Your fist from side to side covers about 10° of sky. A fingertip at arm's length covers about 1° . The Sun and Moon are each $\frac{1}{2}^\circ$ wide. The Big Dipper is 25° long. From the horizon to the point overhead (the zenith) is 90° .

There are finer divisions of angular measure. A degree is made up of 60 arcminutes, and each arcminute is divided into 60 arcseconds.

Right Ascension and Declination

Seen from Earth, the night sky looks like a huge dome with stars stuck on its inside surface. If the Earth beneath us vanished, we'd see stars all around us — and we'd have the breathtaking sensation of hanging at the center of an immense, star-speckled sphere. Astronomers designate the positions of stars by where they are on this celestial sphere.

Picture the Earth hanging at the center of the celestial sphere. Imagine the Earth's latitude and longitude lines expanding outward and printing themselves on the celestial sphere's inside. They now provide a coordinate grid on the sky that tells the position of any star, just as latitude and longitude tell the position of any point on Earth. In the sky, "latitude" is called declination and "longitude" is called right ascension.

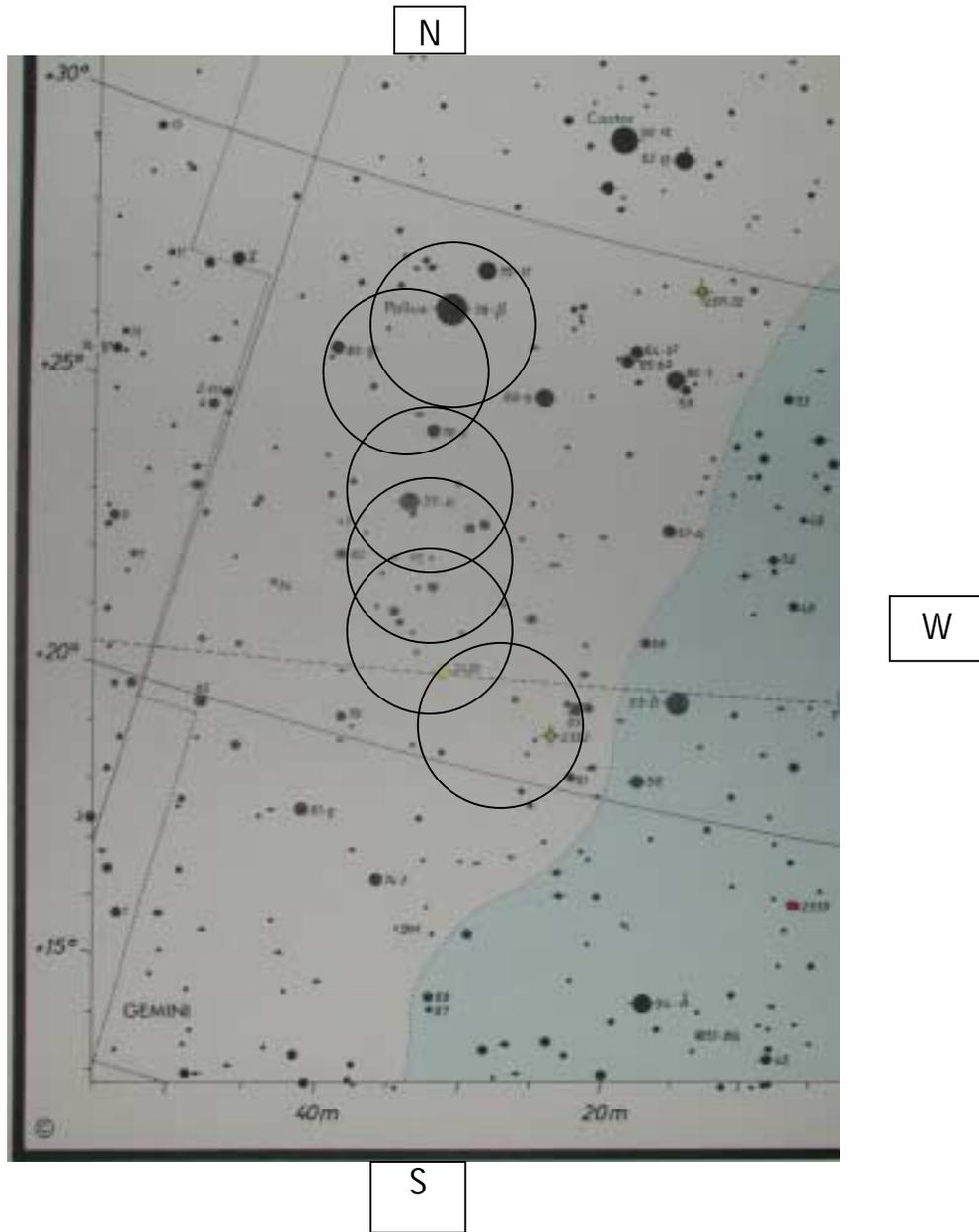
Declination is expressed in degrees, arcminutes, and arcseconds north (+) or south (-) of the celestial equator.

Right ascension is expressed not in degrees but in hours (h), minutes (m), and seconds (s) of time, from 0 to 24 hours. Astronomers set up this arrangement

long ago because the Earth completes one turn in about 24 hours, so the celestial sphere appears to take about 24 hours to complete one turn around Earth.

Using a Star Atlas

Suppose, for instance, you've learned Gemini as it's drawn on the monthly Sky & Telescope charts, where the stars are connected to form two stick figures holding hands. The brightest stars in Gemini (like Pollux and Castor) appear on Chart 5 of Sky Atlas 2000.0 – but at a larger scale and almost lost in a wealth of detail.



Sample Star Hop on Map of Gemini (Ref. Chart 5 of Sky Atlas 2000.0)

First get familiar with directions on the map. East, you'll notice, is left of North on sky maps, not to the right like on maps of the ground. The reason is simple: You look down at the ground but up at the sky.

First determine the size of your the field diameter of the main telescope's lowest-power eyepiece. Locate two stars that just fit into its edges (try pairs in the Big Dipper or Cassiopeia). Then see how many degrees apart these stars are on the map, by referring to the declination scale along the sides. That's the diameter of your eyepiece's field. It will probably be only about 1° or so — the area of sky your little fingernail covers at arm's length. This is so small that it may be hard to identify a good star pair on your map to measure the field size.

Now, using the scale on the margin of the charts, make little rings out of wire — or draw circles on clear plastic — corresponding to your field sizes. By sliding these circles across the charts, you can see exactly what star patterns will pass through your field of view when you sweep across the sky.

Beginners are always surprised at how tiny the view really is. Keep these little tools with the charts; you'll need them whenever you observe.

Now we're ready to go on our first deep-sky hunt.

A Practice Star-Hop

Any observing session should begin with some indoor planning. Let's use Gemini for a dry run. If you know the constellations, you can find its two bright stars, Castor and Pollux, in the sky. These will be our starting point.

A couple inches south of Castor on Chart 5 of Sky Atlas 2000.0 is the planetary nebula NGC 2392, the Eskimo Nebula.



Astrophoto of the Eskimo Nebula, NGC 2392

It is indicated by a little open circle with four spikes. This looks like it might be a nice item to check out. We look it up in Burnham's Celestial Handbook, and learn that it is a small, round 8th-magnitude glow, which is bright enough to show up in most telescopes. So far so good.

The next step is to plan how to get there by star-hopping. This just means following a trail of stars to move the telescope from a place we know, such as Pollux, to some place we don't, such as the location of the nebula. The trick is not to get lost on the way.

The star-hopping route may seem like a lot of trouble to the beginner, whose impulse is just to sweep from Pollux "about the right distance that way." But most deep-sky objects are many times dimmer than the faintest stars on the chart and won't catch your attention even if, by luck, your tiny telescopic field happens to sweep right across them. The only way to succeed is to know exactly where you are at all times. If you suspect you're lost, go back and start over. Have patience. You'll speed up later when practice increases your skill.

Keeping Track of North

The biggest pitfall in going from map to sky is keeping directions straight. Remember that in the sky, celestial north is not up but toward Polaris, no matter how cockeyed this direction may be in the eyepiece. To find north as seen in the eyepiece, just nudge the telescope a bit toward Polaris. New stars will enter from the field's north side, showing you where this is. Turn the map around accordingly, so north on the map is oriented in this direction. This north-nudging trick will become such a habit at the telescope that you'll forget you're even doing it.

Furthering Astronomical Skills

Learning how to see. Why would you have to do something that you may take for granted everyday? Any experienced observer will be able to see vast amounts of detail in an object because they have taken the time to train their own eyes to see more than a novice. This training comes from practice, certainly, but you can apply the essentials to your next viewing session and be amazed at the new things you see.

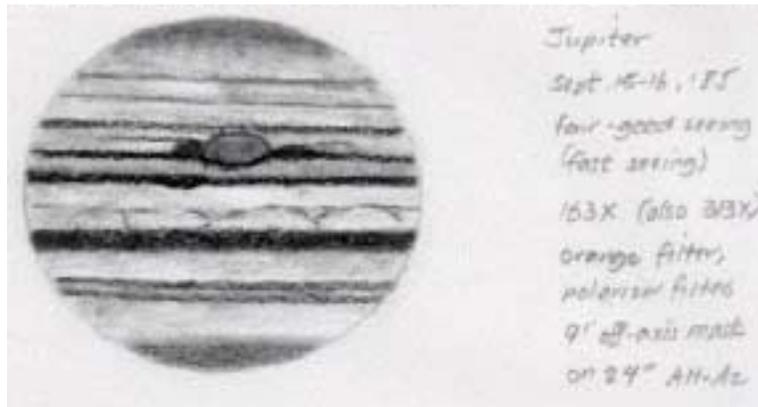
Planetary Viewing

Steady air, patience, and filters are key to seeing as much detail as possible on the planets. A high contrast instrument, ideally a refractor, is helpful to detect the subtle surface features on Mars and the intricate swirling of storms between the temperate belts of Jupiter.

The turbulence of the atmosphere can smooth out for a second and offer the patient observer a glimpse of planetary detail that can be simply amazing. By keeping your eye moving across the image, your brain will begin filling in the

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details of different parts of surface. You will find that high power and a clock drive are essentials for planetary observation. Many observers sketch what they see through the eyepiece. The process of drawing the view forces you to carefully examine each portion of the image, improving your observations skills tremendously. You will begin to pick out subtle features that eluded your initial glimpses. Plan on spending 20-30 minutes minimum on each object.



Eyepiece Sketch of Jupiter by Mel Bartels

Filters enhance features like cloud detail, the ice caps on Mars, and even Lunar details. A short reference chart follows.

- **Blue Filter:** A Wratten #44A, 47B or 80A can be used to detect high altitude clouds on Mars, white ovals and spots in the belts of Jupiter, and the zones of the clouds of Saturn. It can also be used to cut down the glare of the bright Moon. The 80A is the filter to have if you only buy one filter.
- **Green Filter:** A Wratten #58 allows you to see more clearly the edges of the Martian polar caps and enhances the belts and the Great Red Spot in the clouds of Jupiter.
- **Yellow Filter:** A Wratten #8, 12, or 15 can improve the markings in the clouds of Venus and enhance dust storms on Mars.
- **Orange Filter:** A Wratten #21 will be found to be one of the most useful filters to have. It is used to bring out details on Mars and enhance some of the zonal details on Jupiter. An orange filter darkens the blue sky so daytime observations of Jupiter, Venus and the Moon are much improved.

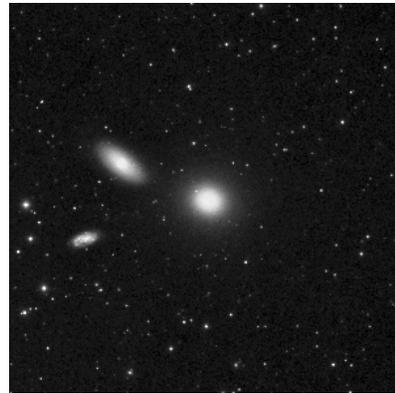
- **Red Filter:** A Wratten #23A, 25, or 25A can be used to enhance contrast on Mars, Jupiter, and Saturn. A red filter, however, is fairly dark, so it works best on larger aperture telescopes that give brighter images. Flipping back and forth between red and blue filters can sometimes bring out subtle coloration on the surface of the Moon.

Low Contrast Deep Sky Objects

One of the most difficult class of objects for an intermediate amateur is of very low contrast, distended objects. These include diffuse nebulas, planetary nebulas, dark nebulas, and faint galaxies. The challenge lies in observing these objects during nights of less than optimum conditions. The first rule is to know what kind of object you are after. Certain nebulae are more visible when using an O-III filter or a nebula filter that remove extraneous wavelengths of light, improving contrast. These filters are completely ineffective when trying to observe galaxies. To spot these, star hop as close as you can get and then there are methods for scanning the sky in a search pattern that will yield success. The trick to spotting dim galaxies is to know what you expect to see through the eyepiece.



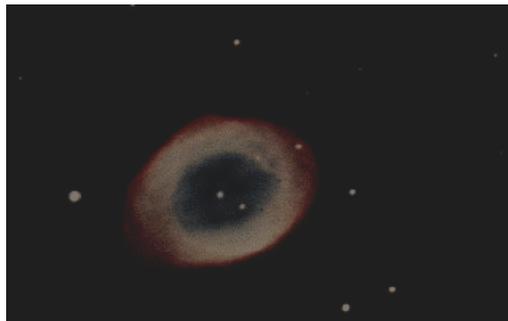
M100



M105



M27



M57

Recording Your Observations

It is fun to observe the heavens, that's why many of us are amateur astronomers! However, in order to make scientifically useful observations or to compare your own observations over years of observing, it is important to

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record your observations in some permanent form. You might use a bound or loose-leaf notebook to maintain your records. Whatever format you use, certain standard information must be recorded.

The form below is one way to organize that information. It is the one suggested by the Astronomical League, but it is only a suggestion. You are free to make copies as you need for recording your own observations. A few comments follow on certain of the data fields.

Date and Time - Since most astronomical observations are made at night, they can span two calendar dates. This can lead to confusion in your records. There are several ways to avoid this confusion: use Universal Time as reported by radio station WWV and others; specify both standard calendar dates, e.g., January 25-26; just be careful of your observation time and report it properly in civil time, noting the date change after midnight. Just pick a method and use it consistently.

Astronomical Seeing - Many observers forget that the telescope's optical path includes a column of atmosphere equal in diameter to the telescope objective. The air within this column is constantly moving, changing density and composition. These factors combine to degrade the observed image. Some estimate of these "seeing conditions" should be included in your observing report: the "seeing" may be important when interpreting your observation at a later date.

The form includes two provisions for estimating seeing: transparency and steadiness. Various observing programs may specify a particular "seeing scale." Be sure to indicate the basis of your estimates. If transparency is the faintest naked eye star visible, enter it as "5.5 mag." If steadiness is on an arbitrary scale of 1 to 10, 10 best, enter it as "7/10."

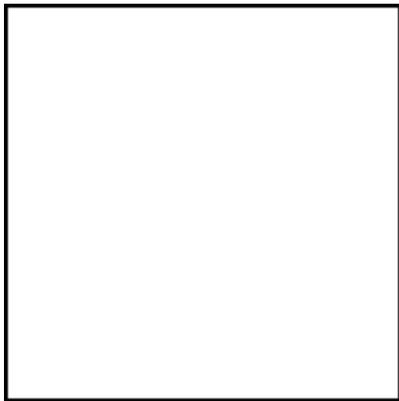
Field Size and Orientation - You should include an indication of scale in any sketches or drawings you make. The angular size of the eyepiece field is often convenient for this. You should also include two perpendicular directions in any field sketch: North (or South) and East (or West). Two directions will indicate any field rotation caused by star diagonals or secondary mirrors.

Observing Log

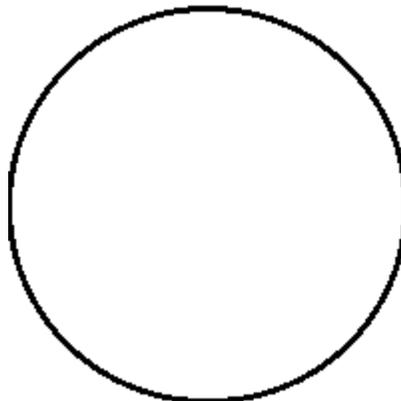
Object _____ Date _____ UTC/civil
Right Ascension _____ Time _____ UTC/std/ds
Declination _____ Seeing: Transparency _____
Constellation _____ Steadiness _____
Magnitude _____ Temperature _____
Size _____ Telescope _____
Eyepiece/Magnification _____
Filters _____

Notes:

Finder Chart:



Field Size: _____



Observer: _____

Observing Programs

Astronomical League sponsors numerous observing programs to challenge and develop an amateur astronomer's abilities. These programs offer a certificate and/or a pin at completion. There is probably an observing program designed around your interests. A couple of good ones to start with include the Universe Sampler program and the formalized Messier observation program. Both help teach the sky while sharpening observing skills. Details of the requirements of these programs can be found on the Astronomical League's website, or contact the club's Astronomical League coordinator.

These programs take about one year to complete and are quite rewarding experiences. The Messier Club observers program requires that you find the objects on your own without using a computerized telescope and have the identity of each object confirmed by another person. This is a great small group project.

The Lunar Club, Sunspotters Club, and Planetary Observers Club programs are in depth studies of these objects you probably thought you were well familiar with. There are many others:

Astronomical League: <http://www.astroleague.org/>

Learner

- Lunar Club
- Urban Observing Club
- Universe Sampler Club
- Binocular
- Binocular Messier Club
- Deep Sky Binocular Club
- Southern Skies Binocular Club

Telescopic

- Messier Club
- Herschel 400 Club
- Herschel II Club
- Caldwell Club
- Arp Peculiar Galaxy Club
- Galaxy Groups & Clusters Club

Topical

- Asteroid Observing Club
- Double Star Club
- Earth Orbiting Satellite Observing Club
- Meteor Club
- Planetary Observers Club
- Sunspotters Club
- Master Observer Club

Star Party Q&A

As an "Intermediate" amateur, you will no doubt be attending Star Parties regularly. Inevitably, the general public will see you as "The Expert" and will ask you questions. Even though you may *think* you're not yet qualified to answer, give it a shot. Your own knowledge and confidence will be increased. It is inevitable that you'll be asked some of the following questions:

1. How powerful is your telescope?
 2. How far away can you see?
 3. How far away is what I'm looking at through your telescope?
 4. Can you see the flags on the Moon?
 5. How much does all this stuff cost?
 6. What is a star?
 7. How big is the Galaxy?
 8. What is a shooting star?
- (See typical answers below)*

And so on...

You have a real opportunity to add to your own astronomical knowledge as well as the knowledge of the person asking the sincere question. If you happen to know the answer, great! But if you don't, why not take a minute or two and see if you can get the answer from another club member or from a book. You'll find that 99% of people who have taken their time to come out to a Star Party are genuinely interested in finding out more about the universe around them and are happy to wait to get a good answer. I have found that knowing solid answers for the questions above will get you through a high majority of the evening's questions. Above all, Have Fun!!

Typical Answers

- **How powerful is your telescope?**
Telescope magnification is the telescopes focal length divided by the eyepiece focal length. A 2000 mm focal length telescope with a 20 mm eyepiece is viewing at 100 X magnification.
- **How far away can you see?**
Galaxies that are 40,000,000 light years away are seen through most amateur telescopes. With the naked eye, the Andromeda galaxy is visible as a faint smudge at 2,200,000 light years away.
- **How far away is what I'm looking at through your telescope?**
Refer to your Messier guide, a copy of The Night Sky Observer's Guide, or of Burnham's Celestial Handbook as starting points.

- **Can you see the flags on the Moon?**

No because they aren't large enough to be resolved by amateur telescopes. The Hubble is theoretically capable of seeing the flags, but all of its highly sensitive CCD detectors are designed exclusively for imaging extremely dim, deep space objects, not something as bright as the surface of the Moon.

- **How much does all this stuff cost?**

You can buy a good quality 8" mirror used amateur telescope for around \$250. You can build a 6" mirror beginner's telescope for around \$150. Come to a star party before you buy and look through different telescopes. Don't buy from a department store.



- **What is a star?**

A mass of hydrogen and helium that has gravitationally condensed and heated up to the point that fusion can take place. Stars do not burn, they 'fuse' elements together just like in the core of a nuclear explosion. The Red stars are big and cool (relatively) and the Blue stars are small and hot. Our Sun, is a yellow-white star, very close to average size and temperature.

- **How big is our galaxy?**

The Milky Way Galaxy is approximately 100,000 light years across and 30,000 light years thick at its core. There are approximately 1 billion stars in our galaxy. Our solar system is located on the outer edge of one of the spiral arms. Our entire solar system orbits once around our galaxy about every 250 million years. For a sense of the size of the Milky Way, if our entire solar system could be shrunk down to the size of a coffee mug, on that same scale the Milky Way Galaxy would be twice the size of the entire North American continent.

- **What is a shooting star?**

A meteorite. Most meteorites are no larger than a grain of rice, but they are moving extremely fast (50,000 mi/hr) when they hit the upper atmosphere of the Earth. All of that velocity is converted into heat and light, making a memorable streak of light in the night sky.

FEEDBACK FORM

I would like to know more about: _____

Comments: _____

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Date: _____.

	Strongly Disagree	Disagree	Average	Agree	Strongly Agree	<i>Not Applicable</i>
I found the class useful	1	2	3	4	5	N/A
The class had the right amount of detail	1	2	3	4	5	N/A
Subjects were explained well	1	2	3	4	5	N/A
The pace of the class was right for me	1	2	3	4	5	N/A
I know more about observing objects	1	2	3	4	5	N/A
I know more about observing programs	1	2	3	4	5	N/A
I know more about how to find objects	1	2	3	4	5	N/A
I know who to call if I have problems	1	2	3	4	5	N/A

We could have skipped the section about: _____

I would like to know more about: _____

Comments: _____

OPTIONAL: Name _____