AAC Observing Program and Newcomers Orientation Guidelines

by Philip Sacco

Purpose:

To create a regular training program for our newcomers and beginners alike. The goal being to give them exposure to the essential information needed for the proper and effective use and selection of their own equipment as well as the proper use and care of the clubs facility and equipment.

Intent:

The intent is multifold.

1) With the increased number of new members; to insure better control and security of our facility and equipment
2) To develop a regular teaching and evaluation program
3) To promote our new membership to take an active part in some form of more regular or formalized, personal viewing programs. Thus to offer the type of assistance they may need in developing their skills, and guidance to find the material they may need in it's creation and execution.

Basic format and Outline of Procedure:

The monthly Saturday night beginners program should regularly begin well in the daylight hours so as exposure to the training material as well as becoming familiar with each others faces is more facilitated.

The general outline of material should always be presented completely. Stress should be made to the effect that we understand the volume of information is large, but we need to ensure that the basics are covered with everyone. Our hope is that the enjoyment of the evening will encourage their repeatedly return. This ensures the proper use of our facility and equipment by all and provides for our mutual enjoyment and security.

Once dark, each session will typically continue with the exploration of one or two constellations and general information about its mythology and makeup of its constituent stars. When possible, the constellations to be observed will be announced in the Focal Point in advance. Study will begin naked eye, then progress to binocular viewing and the use of various telescopes. An introduction to the Observatory and its equipment will be made. The telescopes to be used will typically be the smaller portable scopes. Viewing with the observatory equipment will be stressed on the Friday night sessions.

At any time, a member may ask for an evaluation. The evaluation should consist of a very basic set of questions with the intent being to assess the competence of the members general knowledge and skills required for the safe and proper use of their own equipment as well as ours. Satisfactory completion of the evaluation will entitle the member to the combinations to all the locks of the facility.

Any member visiting the site and shown the basics of the observing field i.e. the power circuits, heaters, coffee pots, etc., will be provided with the combination to the gate lock for access to the site.

Observatory Procedures

The following is a compilation of the procedures to be followed when opening the observatory for viewing.

- Switch 'on' main power breaker on pole by warm up shed. The two smaller breakers in the breaker box will need to display "on" as well.

- Open up the warm up shed and air out. Check for spiders and ants. Spray if needed.

- Check power breakers in breaker box located on wall to left of door. Plug in heaters or coffee pot if needed. These first three items are all that a member be aware of to receive the lock combo for the gate.

- Open Observatory, check for cats and other small beasts. Make sure the power had been properly turned off and the scopes are in their proper home positions. If any equipment is noted to be missing, or not properly stowed, please notify Philip Sacco or Art Russell. Unlatch the catches on the East and West walls and roll off the roof with caution. Make sure the 20" will be cleared when the roof is rolled off.

- Uncover apertures of the 20" and the 10". Be careful of hornets and spiders when removing cover from 10". The 20" has a series of four "bungie" catches to be released prior to removing the aperture seal. HANG ON TO THIS BUGGER CAUSE IF DROPPED, IT WILL BREAK YOUR TOES!!!

- Plug in the 10" in the southern wall. The 20" has two plugs to be plugged in the receptacle located on the west side of the 20"s pillar. Note that the setting circles will already be illuminated. They are controlled by the power breaker on the pole by the warm up shed and come on when the circuit breakers are switched on.

- Remove film canisters from viewing draw tubes. Note which lens require the focal length extension.

- Note which direction the Secondary in the 20" is turned for use. To change direction of the secondary, Pull the detent located on the back of the secondary and rotate whole secondary assembly until it locks in place for the alternate viewing position. Do not try to manhandle the entire assembly!!! This will ruin the collimation, and possibly damage the scope.....

When locking up...

- Make sure all eyepieces and accessories are returned to the eyebox case and secured.

- Replace film canisters in draw tubes and reverse the above procedures. Make sure the scopes are sealed and in their "Home' positions.

- Make sure all heaters and coffee pots etc. are unplugged and all garbage is removed. If any problems arise which result in the damage of any equipment, or any items are noted missing, please notify
  Philip Sacco 404-296-6332, or Art Russell 404-373-4119.

Remember this is an environmentally conscious club

Leave the facility as you would like to find it

BASIC OUTLINE FOR BEGINNERS SESSION

It's as easy as 1, 2, 3

WELCOME AND INTRODUCTION

1. Viewing: Hope for the Best, Prepare for the worst

A. Basics:

- Weather: Transparency, Seeing, and DEW; Ready, Set, SEE
- Dress for Success: Head to Foot
- A HIT LIST or Just Browsing: Viewing for an Agenda, or an Agenda for Viewing

B. The Hand is the Handiest Tool

- Over There...The problems of perspective.... Getting There
- How Big...The 'Rule of Thumb': Having a Ruler in the Palm of your hand

C. Getting the BIG Picture

- Field of view...eyes, Telrad, binocs and viewfinders, telescopes: The Effects of Magnification
- Which way is Up? When East is West and Up is Down....!: Lens Inversion

D. Viewing Programs or 'How Can I Remember all this STUFF!!'

- The Astronomical League Clubs: A "Stellar" introduction
- To Be or Not to Be a .....**ZOMBIE!!** **Having FUN!!**

2. Equipment: What you see is what you get.....

A. The Eyes: The 'Eyes' Have It!!

- Red Light/White Light: Protecting Night Vision
- Exit Pupil---Sounds painful: More than Enough
- How Faint?! Visual magnitudes and assessing the night
- What can I see? Equipment for the right occasion

B. Binoculars

- How big is big enough: 'X' x 'X'
- See What?! Binocular Objects

C. Telescopes

- General Types: Refs; Cats; Maks; and Dobs
- Mounts: Alt-azimuth vs. Equatorial
- Viewfinders: To Magnify or NOT
- Size or 'How much does it Magnify?' The ERROR of advertisement
- Aperture------Aperture-----APERTURE: The Benefits of BIGGNESS
- Electronics: 'I've got the Power' or Flying by the seat of your pants...
- Bells and Whistles: Frills with a Price

3. The Sky:

A. The Celestial Sphere

- Arcminutes and Arcseconds: The Clock in the Sky
- Right Ascension, and Declination: 'As The World Turns'
- The Planisphere, Stellar-Scope and Star Atlas: Road maps to the Heavens

B. Targets in the Sky

- Visual Impressions: Big, Bright, and Textured vs. the dim, faint, and fuzzy
- Time and Distance: The Art of catching Photons.....They may be OLD, but THEY AIN'T SLOW

BEGINNERS ORIENTATION AND WELCOME

by Philip Sacco 6/97

Welcome

Good evening. My name is _____, I (personal info), and on behalf of the Atlanta Astronomy Club I'd like to welcome you all here this evening for our Beginners Orientation and Star Gaze.

The purpose of this orientation is to expose you to the basics of astronomy. Our hope is to give you the most exposure possible in a minimal amount of time so as to maximize your enjoyment of our evening tonight and hopefully to instill in you a love for the heavens and a continued adventure with our hobby. If you don't have an interest in learning the basics, we welcome you to 'Hang out!' for the viewing session and visit with us as long as you like this evening. I'm sure there will be a Zombie or two around to keep things going all night.....

We will not bog you down with names and dates, merely the most essential information necessary to reduce your intimidation of the equipment and enhance your understanding of our cosmic backyard and the hardware to explore it with. We are **AWARE** that the volume of information we will throw at you may seem incredibly vast, but as you will soon realize, the information covers many topics very generally. As the topics are rather abbreviated as well as interrelated, I'm sure you'll find the orientation to be thorough, to the point and **most** informative. Our hope is that you will avail yourself and join us many more evenings in the future, possibly even becoming a member of our club and continuing your adventure and study of the heavens on your own.

It is NOT our intention that you LEARN all of this information tonight, as some people may require weeks to absorb some of the fine points to a degree of comfortable usage. Astronomy is a wonderful subject, covering a wide range of topics and details. As you gain exposure and define your interest, you will find a wealth of information available for your personal enjoyment. Members shown to be accomplished with the nuts and bolts presented in our orientation, will be given the pass combos for our facility and encouraged to check out the club loaner scopes for their own use elsewhere. This Orientation **IS intended** to provide all the information necessary to complete the evaluation to our clubs satisfaction.

Introduction

The information we will present tonight will be broken down into three basic categories. The **"Basics of Viewing", "Equipment"** and **"The Sky"**. We would like this to be as informal and comfortable for you as possible *and* we want to get through the information as quickly as possible. We are aware that this orientation may feel like a crash course (it is),----------but we encourage your questions, and want to make sure *you have something to ask a question about!* We can begin in any topic, and will begin with the Basics unless someone would like to make a suggestion from the outline.....?

1. VIEWING: This topic is intended to help you better prepare yourself to undertake a night under the stars and get the most out of it. It all begins with the weather and ends with the weather. **'Hope for the best, Prepare for the Worst'.**

A. BASICS

- **Weather: Transparency, Seeing, and Dew**. **READY, SET.....*VIEW***

Knowing the weather, and what can and can't be seen under various conditions is essential for a frustration free observing program.

THINGS TO LOOK FOR Reading the weather: During the day look at the **contrails** left by high altitude jets. The longer the contrail, the more water vapor in the sky and the worse the seeing can be expected to be. Also look for 'Horse Tail' clouds. They are a fair indication of a clear, cool weather front moving in.

Transparency: This is a term used to describe the basic clarity or visibility of the sky. The greater the transparency, the fainter an objects may be and still be seen. Poor transparency is noted as a gray sky. Light pollution plays a significant role in transparency loss. Mercury vapor lights, and high pressure sodium lights are especially bad light polluters. Light pollution may be combated somewhat with the use of certain filters in conjunction with an eyepiece, but most effectively

through Anti-Light Pollution Laws. AAC has been instrumental in the passing of preliminary legislation through the efforts of club member Tom Buchanan.

Under the best skies, the sky should appear black, with the background treeline indistinguishable from the heavens. The faintest objects to be seen under ideal skies are typically 6 to 6.5 magnitude depending on your eyes. More about the magnitude scale when we discuss the sky.

Some objects for viewing will not be disturbed by poor transparency. For instance viewing the Moon, the Planets or double stars generally will not be effected too much by the effects of poor transparency.

Seeing: Seeing refers to the stability of the atmosphere. A lot of water in the air overhead is a sure way to ruin seeing. When seeing is poor, objects viewed through a telescope seem to 'swim', or 'boil'. Stars will also 'twinkle' more in bad seeing. This effect can also be seen when stars are rising or setting. This is because their light must pass thru more atmosphere. The same or similar effect may be shown by a telescope which has not been allowed to thermally equilibrate to the outside air. This type of poor seeing is caused by convection currents inside of the telescope. A good general rule of thumb is to let your telescope sit outside for 30 min. to and hour before you begin your viewing. Get to know your scope. Some will require more time, some less. The general effect of poor seeing is the lose of fine detail.

One example of objects to test seeing with are double stars. The better the seeing, the closer a pair may be and still be seen as two distinct stars. Poor seeing will ruin most viewing.

Dew: The most important information to get from a weather report is the **DEW POINT.** The higher the temperature for the dew point, the more water there is in the air, and the worse seeing will be. Another point about dew, when it begins to fall, optics are the first to suffer. **Never wipe dew off a lens or mirror!** A gentle stream of warm air will remove the dew easily. The temperature of the lens or mirror need be just a little warmer than the air to keep dew from falling. A slight breeze will also inhibit dew forming.

The worse effects of dew can be seen on any reference material you may have exposed to the air. Unprotected or uncovered paper will wrinkle up.

- **Dress for success: HEAD TO FOOT**

  This is a very seasonal subject and during the summer months we only need to be concerned with Bugs. A note on bugs.....**Avon's Skin-So-Soft** is said to be unparalleled for combating the biting critters. **'Off'** works well, but a word of caution about using aerosols around telescopes....**don't do it!** The fine aerosol will deposit on exposed lens surfaces, and will ruin the fine optical coatings used on the lens.

  Our clubs facility is complete with a warm up shed for those times when you need a little break for coffee, or to relax for a while during some of those long astrophoto exposures.....

  (To be covered when the weather is broaching cold: It can get very cold out under the open sky because on a clear night we have no cloud cover to act as a blanket over the earth, and all of our heat radiates into space. Plan on the temperature at your observing site to be 20 degrees cooler than in the city. The best way to keep your extremities warm is to wear a warm cap. Our bodies are designed to keep our brain at a working temperature. If your body cools off to a certain point, heat (i.e. blood circulation) from the extremities is directed to the brain. For added warmth, some people find the use of battery operated socks, chemical or charcoal pocket heaters, and Mittens rather than gloves of good use. As for the body, Layer, Layer, Layer. If you get warm, you can shed layers, but if you get cold, you may be forced to give up a great night. Thick soled, impermeable boots are a great aid to keep the feet warm. I have found that making sure all of my accessories are not to close at hand keeps me moving around more and thus generally warmer than if I were to sit stationary at the eyepiece all night. Do move around, visit and make friends around you and take regular breaks when you feel the chill setting in.)

- **HIT LIST** or just **'BROWSING'**: **VIEWING AS AN AGENDA, or AN AGENDA FOR VIEWING**

  Once the conditions of the night have been determined and you are prepared for your evening, you may then decide on one of your viewing programs. Having an agenda of objects to hunt is a great way to maximize your viewing enjoyment. To develop an agenda requires a certain amount of exposure to the various celestial objects. You can't know what you like to look at until you know what things look like, or rather what there is to look at.....! Starting a general viewing list is a good way to gain exposure to the heavens. More about viewing lists in just a minute. Whatever form your viewing takes, many of us have found the many benefits of keeping a **'Star Log'** or journal of our evening hunts. A written memory lasts a lot longer than a mental image. Just as your viewing program will become very individualized, so will your logbook. It can be very in-depth, including sketches you make at the eyepiece, date, instrument used, weather, etc., or it may be a very simple list of the objects seen.

  Just as when taking a long trip overseas, one typically takes pictures of their travels and the places they have seen, a **star log** can be as valuable as a picture book....as a matter of fact why not take pictures of the heavenly objects you have seen....Astrophotography is just one more aspect of our hobby that many of us enjoy. Don't be surprised if you see our members out here taking pictures with conventional cameras, or even with high tech CCD imaging computers. Photometry as well as spectrophotometry and infarometry are also easily performed here at our facility using our clubs telescopes. Planetary studies as well as asteroid, comet, and meteor watches are also often enjoyed by our membership.

B. The Hand is the Handiest Tool

- **Over there....The problem of perspective..... GETTING THERE**

A common error often made when trying to point a celestial object out to a friend is pointing at the object and repeatedly saying ,"Over there, that one, see it?" No one else can see the object you so arduously point out because each of us has our own unique point of view of the heavens. Start with an object or a star easily identified and apply the **.....'RULE OF THUMB'**

- **How Big...The 'Rule of Thumb**: **Having a Ruler in the Palm of your hand**

We will now show how the hand can be used as a simple standard of measure for us all so that we may measure and gauge distances in the heavens. We are all proportioned alike, so at arms length each of our hands and fingers will represent a similar size of space in the heavens as seen by each of us individually. Make a fist and extend your arm fully in front of you. The breadth of your fist is roughly 10 degrees. Now extend your thumb. From the end of your thumb to the opposite side of your fist is roughly 15 degrees. Likewise, by splaying the index finger and pinkie, one may describe 15 degrees. Now extend your little finger and thumb.....from the tip of your thumb to the tip of your pinkie is roughly 20 degrees. Each finger is 2-2.5 degrees thick, the pinkie being 1 degree.

C. Getting the BIG Picture

- **Field of View... eyes, Telrad and viewfinders, binocs, and telescopes: The effects of Magnification**

The entire expanse seen by your eyes at any one time is what is referred to as ones **'field of view'**.. The total expanse of sky seen at any one time will depend on the amount of magnification in use, if any. The use of a Telrad type of viewfinder or your naked eyes will result in the widest field of view, but the smallest image scales, and only the brightest visible objects will be seen. As we increase the amount of magnification of our view, the field of view shrinks. We see a smaller and smaller piece of the sky. To balance this off, however, we do gain the advantage of seeing more detail of the object viewed. There are simple equations available to calculate ones theoretical field of view. Another method to use is to actually time how long it takes for an object to traverse your view.
Very large objects with a very low surface brightness, or LSB objects, are best seen with low magnification and a wide field of view.

- **Which way is Up? When East is West and Up is Down...!: Lens Inversion**

Now for one of the most confusing visual phenomena. **Lens Inversion**. This problem can best be demonstrated when we view the moon, if possible, later this evening. Binoculars use prisms to correct the image before it reaches your eye, so when you look thru them, everything is right side up and not reversed left to right like with a mirror. Any Lens system you may look thru will invert the image, whereas any mirror system you look thru will turn the image around (left to right or east to west). This is what is referred to as a 'mirror image'. Now imagine what happens when you look thru a telescope using a combination of lens' and mirrors'! This can be very disorienting when looking at, say, a picture of an object your viewing like the moon, and the image you see in your telescope is upside down and reversed!! Take your time and gently nudge the telescope to figure out what kind of view you have. If you simply let the object drift thru the view you will be able to tell which direction East and West is. Just remember that the object is going to be moving towards the West. If you move the **telescope** towards the Pole star, any object in the view will move in the Southerly direction. Again take your time and with a little patience, you will be able to make the mental adjustments very easily. To be honest with you, most of the time you won't be concerned with it at all. Just be aware of the phenomena, and it will sink in.

D. Viewing Programs or 'How Can I Remember all this STUFF?!

- **The Astronomical League Clubs: A "Stellar" Introduction**

Earlier we mentioned the establishment of your personal viewing program or agenda. One of the best ways to gain exposure to the various celestial objects, and increase your viewing skills, is to avail yourself of the many viewing programs promoted by the Astronomical League. Membership in the League is included in your membership with our club, thereby entitling our membership to the certificates and awards they offer. The various objects we will look at tonight can be found on these lists, and we encourage you to use these lists to gain experience quickly. Let's take a quick

The Messier Club- This club entails viewing the 110 objects catalogued by the French Comet Hunter Charles Messier. They include the full gamut of celestial objects, and will offer participants exposure to a host of beautiful objects. By the time you finish this list, your eyes and overall viewing skills will have improved remarkably.

The Messier Binocular Club- This club entails viewing a host of objects found on the above list which are to be hunted with binoculars. Patience will be needed for this one as good seeing conditions will be a must. Completing this list will assure your ability to navigate the heavens and increase your eye sensitivity.

The Binary Star Club- This club involves the viewing of a list of binary or double stars. Exposure to this list will train your eyes to see very fine detail, and will allow you to see the wonderful variety of colors stars display.

The Lunar Club- Well as you probably guessed, this list involves gazing at the moon. The list is of some 100 features. Some will be viewed naked eye, some with binoculars, and some with a telescope. A wealth of knowledge about the moon, our closest neighbor, will be learned by the curious endeavoring to enter this club.

The Herschel 400- This list is probably best attempted after some experience has been gained in familiarizing oneself with the sky. The objects can be quite challenging to find and identify. I can honestly say that a fine appreciation for the brighter more detailed objects will be gained by attempting to complete this grueling list. To be sure, completing this one will have honed your viewing skills to the finest point, and taken you where truly few have ventured.

The VIP Program- This internationally acclaimed **Visual Impression Program** is the brain child of club member and Zombie- Rich Jakiel. Pilgrims of the night sky will be requested to look at and draw their visual impressions of group of keenly selected objects. Take a grand tour from the craters of our neighboring moon to distant galaxies....!

These are a few suggested clubs to give you some experience with a wide variety of objects. Many more programs can be found on the web, or by talking to our members. There's always the GREAT GLOBULAR CHALLENGE.....

Combined with a viewing log, participating in a viewing program like one listed above will provide a written memory for a lifetime.

- **To be or not to be a .....ZOMBIE!!** **Having FUN!!**

Whatever your viewing may entail, you can always count on a few late night **DIE-HARDS** to weather the weather, and stay up 'til dawn breaks.....After all....How else can you get to use that Solar Filter unless the sun is up (of course you have to wait all night for the sun to come up don't you?!) I am sure that you will be able to pick these **Zombies** by their deliberate movements earned by lack of sleep, the pallor from lack of sun shine, the forced wakefulness by copious amounts of sugar and coffee ingestion..... The DIE- HARDS..... The

.....ZOMBIE SQUAD.....!!!!

These individuals are among the most earnest and helpful gazers to be found on the field. For the most part, they relish the insurgence of new blood to share their exuberance with, and to pass on their legacy of experience and tricks of the trade to.....Just remember.....The whole idea is to **HAVE FUN with your viewing.**

2. Equipment: What you see is what you get.....!

A. The Eyes: The Eyes Have It!!

The most valuable equipment you will ever have with you in the field will be your eyes. They are capable of seeing objects as dim as 6.5 magnitude easily under good clear skies. They are also capable of taking you 2.5 million years into the past. We'll talk a little more about this later....Now for some basics....

- **Red Light/White Light** ***'BRIGHT LIGHT.....BRIGHT LIGHT!***

Just as you will need to let your telescope acclimate to the night air, you will need to let your eyes acclimate to the night sky. It will take 15 to 30 minutes for your eyes to adapt to the dark outdoors. The eye sees by two different type of cells in the retina:

Cones- These cells are located near the center of the retina, and are responsible for the recognition of color. And more importantly for us the-

Rod- These are specialized cells which are located around the outside of the retina, and are responsible for seeing shades of gray or as we say ***'Contrast'***. The more subtle details seen in celestial objects can best be seen by ***'Averted Vision'***. This entails looking somewhat to the side of the object you really want to see, thus allowing its light to fall on your rods and thereby noting the slight contrasts it may display. Our **Rods** are very sensitive to white light and exposure to any white light will require time to allow your eyes to dark adapt again...! This is very disturbing when you are chasing 'faint fuzzies' as we like to call them. If any light is needed, it should be of the **RED Variety,** and only as bright as needed. Flashlights made for Astronomy with adjustable red led bulbs are available.

Another aspect which is of interest to us concerning our dark adaptation deals with our **Pupils.**

- **Exit Pupil---Sounds PAINFUL.....!** **More then Enough**

As your eyes become dark adapted, the muscles controlling your pupil will relax, and your pupil will obtain its largest diameter once the eye is completely dark adapted. It can be handy to know what your maximum pupil size is to determine your

optimal binocular power, or optimal lowest power lens(or *ocular*) to be used in your telescope. Remember that the lowest power magnification will *typically provide* you with the widest *field of view*. Each lens you use in your telescopes will provide a different amount of what is referred to as **EXIT PUPIL. Exit Pupil** refers to the size of the light bundle provided by the lens. If the **Exit Pupil** for a lens is larger at any time than your actual pupil diameter, your eye will not be capable of taking in all the light being provided by the lens. The image brightness will suffer for that reason. This is a detail not very important unless you are considering to purchase a low power wide angle lens. It never is a good thing to spend your money and never be able to take advantage of what you have bought. This would be similar to buying a high speed race car, and having a governor placed on it deliberately to keep you from going faster than say 20 mph. Silly, Huh? To calculate the exit pupil of a lens:

Exit Pupil = aperture diameter/magnification.

We'll look at how to figure the magnification of a telescope when we discuss scopes in general. Remember, this is very specific information and you generally will only need it in considering the purchase of a new lens'.

- **Visual magnitudes: How Faint?!**

When we refer to the brightness of an object in the heavens, we refer to it's **Apparent Magnitude.** This refers to how bright the object appears to our eyes relative to other objects in the sky. Originally this scale was determined before telescopes were invented, and only the visible sky was gauged. The brightest objects at that time were given a magnitude of -0-. After a long series of modifications, our current scale has evolved. The brighter an object, the smaller it's magnitude rating, and the dimmer the object, the larger the number. The sun rates a -29, the moon about a -23, and the faintest object to be seen with the naked eye about 6.5, as we mentioned earlier. The most powerful telescopes in use today can see somewhat on the order of +26. To give you an idea of how the scale relates these comparative brightness': **for each unit of difference between the magnitudes of two objects, the brighter object is some 2.5 times brighter than the dimmer object.** A difference of 5 units would make the brighter object 100x brighter.

Would anyone like to take a guess at how faint a 26th mag. object would be? A telescope which can see an object this faint would be compared to seeing the glow of a cigar on the surface of the moon! Charts are available in most Astronomy reference books to give you an indication about how faint an object any sized telescope may see. Now you will be able to do your own judging of the night sky for transparency and overall visibility. With the use of star charts or atlas' you will be able to look for the faintest star you can see, look it up an tell right away how good the viewing may be. Remember.....to see 6-6.5 magnitude would indicate a good sky.

- **The Right Equipment for the occasion What can I see?**

Now that you have been exposed to some essential info, you are in a better position to understand the various applications for the different equipment. Just as you'd use a bulldozer to dig a big ditch, and not to plant daisies, some objects in the sky are best seen with binoculars rather than with a large telescope. Let's look at some of the particulars....

B. Binoculars

- **10x30, 7x50, or 8x70: How big is big enough**

Look at your binoculars. Somewhere on them will be listed two numbers separated by an 'x'. The first number refers to the magnification of the binoculars, and the second number tells you the size of the main or **Primary Lens.** This basically tells you how big the light gathering end of the binocs are. We will also use this term when we talk about telescopes. The **Aperture**, or **Primary Lens/ or Mirror** of an instrument refers to the instruments light gathering ability. The more light it can gather, the fainter an object may be seen.

If you divide the aperture of the binoculars by the square of the magnification, you will have derived the **Relative Light Efficiency** or **RLE** of the binocs. This number will indicate the relative brightness of an object. For example: You have 7x50 binocs. This means the magnification is 7, and the aperture is 50mm in diameter. 50/7x7=50/49=1 1/49. This would be good for astronomy use. As the number decreases, so does your image brightness. A number = or > 1 would be good for astronomy. A rating about 1 would allow you to see object some 20 times fainter than seen with the naked eye. This would allow you to see objects to below the 9th magnitude. Some objects which may be seen at this level include: the four Galilean Moons of Jupiter, and open star clusters such as the one known as the Beehive.

- **Binocular Objects: See WHAT?!**

Binoculars are exceptionally good for viewing very large, very faint objects because they don't spread out the already faint light of the object. O.K., O.K., you're going to ask me....so what good is a telescope?! That's where **Aperture 'shines'** so to say. I will tell you a little more about this when we talk about Telescopes themselves...

C. Telescopes

- **General Types: Refs, Maks, Cats and Dobs**

Telescopes come in all types of sizes and shapes. Many of you will see telescopes in use out here the likes of which you have never seen. As a matter of fact, don't be surprised if you don't see the type of telescope you're familiar with at all! Big ones, short ones, fat ones and tall ones.....What gives...? What happened to the white or brass colored ones we saw as kids.....?

Refractors: This type of telescope is the most familiar to us. It is the 'Classic' shape. This was the type of scope used by Galileo. The **elements** of these telescopes are a series of lens. You look in one end ant the light comes in the other. These types of 'scopes are typically very well suited for looking at the moon and the planets. Due to the use of lens, there will be a slight false color of the objects viewed. Aperture to aperture, this type of scope is by far the most expensive when you get over 2 inches in diameter. Being a closed system, the internal optics will tend to stay clean and there is never the problem of **'Collimation'**, but they equilibrate to temperature slowly**.** This type of scope is not known for it's portability.

Reflectors: Also known as **'Newtonian'**, the principle components of this type of scope being mirrors. These scopes are typically best for viewing '**Deep Sky'** objects, or rather objects beyond our solar system or galaxy. The color of the object viewed is true. **'Newtonian'** scopes are among the best investment for aperture size, with **'Dobs'** or 'light buckets' as they are sometime called, being the best deal on aperture and mount for your money.

Newtonians will need periodic **collimating** in order to keep the mirrors aligned properly. Being an open system, the primary mirror will get dirty, and you may have a problem with convection currents until the scope equilibrates to air temperature.

Catadioptric: These scopes use a combination of mirrors and lens'. The basic **'Cat'** design is not a closed system as are the **Cassegrains**. Being a closed systems, the **Cassegrains** will not quickly thermally equilibrate, but the internal optics will stay cleaner. They are typically of the more sophisticated design of scope making them a little pricey for their aperture. This type of scope is by far the most versatile for your money, and are a very good choice for astrophotography. They are often touted as among the more portable type of scope. The most popular style of this type of scope is referred to as **'Schmidt-Cassegrains'.**

Maksutov: This type of scope is essentially the same as a **'cat'**, with one primary difference. When focusing, the primary mirror doesn't adjust for focus as it does in a 'cat', but rather the '**Ocular**' position is adjusted for focus. These scopes as well as the **'cats'** are among the best for Planetary and Lunar viewing.

- **Mounts: Dobs, Alt-Az, and Equatorials**

Dobs: Popularized by a Monk named John Dobson, and named after him, this type of mount is the easiest to construct and least expensive to purchase. The scope rests in a **'rocker box'** and functions like an **'Alt-Az'** mount providing movement in vertical and horizontal directions. The beauty of these mounts is the extreme ease of set up. By the way, John Dobson would rather you call these scopes **"Alt-Az" scopes.** He isn't particularly fond of having them called by his name...

Alt-Az: These mounts may be simple swivel mounts for the scope, or slightly more elaborate **'Fork Mounts'**. Looking like a large tuning fork attached to the scope, this style of mount provides simple no frills use of your scope.

Equatorial: This type of mount has a rather imposing look with visible cables and gears. Don't let the looks fool you though, these mounts once understood make finding and following an object as it moves westward through the sky, very easy. This type of mount is intended to be aligned with the polar axis of the earth thus allowing you to compensate for the earth's rotational movement. They are also typically equipped with **'Setting Circles'** useful for locating celestial objects in conjunction with a **'Star Atlas'**. They may be motorized or manually operated. The trade off of this mount is the amount of time it takes to properly set them up for use, and their higher price.

- **Viewfinders: To Magnify or Not to Magnify...THAT is the question...**

A viewfinder is essential to know where your scope is pointed, and to direct your view to a spot that you want to look at. They come in two basic varieties: Magnifying and non-magnifying.

Magnifying: This type of viewfinder is very helpful to get a better look at an area you are looking for an object in. They give you basically a binocular type field of view which you will remember to be low magnification and wide field of view. A basic problem in using this type of viewfinder is that your visual image in the viewfinder will be upside down from what your naked eye will show. This can be corrected.....for a price.....! Also, being that you are magnifying your view, you will see many more stars thru the viewfinder than you will see by eye. This can be very confusing and leads a lot of people to the use of a fairly new type of viewfinder....non-magnifying...

Non-magnifying: This type of viewfinder seems to project an illuminated holographic image either of a bullseye or of a laser sight spot onto the sky for you to aim your scope. The beauty of these finders is that they do not magnify the visual image of the sky, and you only see the stars you normally see by eye. The image is typically thru a clear view screen, so the sky stays right side up as well. These finders are simple, easy to get used to, and also cheaper than a conventional finder.

One type in particular, called a **'Telrad'**, offer an additional bonus. On a some star atlas', you can use a template in conjunction with a **'Telrad'** to see how the **Telrads** finder target will look in the sky. This is very helpful in aiming the scope to find tough objects.

- **Size or 'How much does it Magnify?'** **The ERROR of advertisement**

When selling you a scope, the feature most department stores will sell you on will be how POWERFUL the scope is they want you to buy. Magnification has more to do with the eyepieces (or **'oculars')** you use in your scope. To figure out the magnification of your scope at any time, you must know two things.....the **'Focal Length'** of your scope and the '**Focal Length'** of your ocular. The focal length of the telescope or ocular will generally be marked on them somewhere. Simply, divide the focal length of the scope by the f.l. of the ocular and you have your magnification! For example:

Let's assume you have a scope with a focal length of 2000mm, and an ocular of f.l. of 20mm. **2000/20=100**. Your combination yields 100 power

A scope with a focal length of 1200mm with the **same ocular** of 20mm f.l. would give a magnification of **1200/20=60x** or 60 power. The same eyepiece, two different view...

Remember that the larger your aperture is, the brighter your image will be. The brighter your image is to start with, the more you can magnify it and get a good view. A good rule to remember is the **'Rule of 50'**. If you multiply your aperture in inches by **50** you will derive the **general maximum magnification** for your scope. Think of image brightness and magnification like this. Your image is only as bright as it is to start with. As you magnify an image, you spread it's image brightness over a larger area. Another way to think of it is to think of paint. Equate the initial image brightness to say a pint of white paint. One pint can cover a sheet of paper very easily, and very densely. Now if we want to make that sheet of paper as big as a wall, and use the same pint to cover it equally, the end result will be a somewhat washed out white. As you magnify your image, **image brightness decreases**, and detail is lost. Experience with your scope will help you to find the most pleasing image scale for your viewing of an object.

- Aperture-------*Aperture*--------**APERTURE:** The benefits of **BIGGNESS**

Aperture must surely be the one most important feature of a scope. The Larger the aperture, the brighter your image. The brighter your image, the more you can magnify it. The best way to compare the ability of two scopes of different aperture size, is to compare the difference in the square of their apertures. Now I'm going to try to make a point so stay with me a minute. Let's look at this simple comparison.

Let's say you want to compare a '2 inch scope' to a '3-inch scope'. 2 squared = 4, whereas 3 squared = 9. Comparing the two numbers we find 9 is 2.25 times greater than 4. This means that the 3 inch scope has 2.25 times the light gathering ability than a 2 inch scope. Although you only have added 1 inch to the diameter, or in this case increased the diameter of the 2 inch scope by 50 %, you increased the image brightness by 225%!! Let's quickly look at a couple more examples to give you a real feel for how fast things change.

The same 2 inch scope compared to a 4 inch scope: 2x2=4, 4x4=16, 16 is **4 times** greater than 4. The diameter has been doubled, but the image brightness is **4 times greater**.....you increased the diameter by 100% and the image brightness by **400%!!**

2 inch compared to a 6 inch: 2x2=4, 6x6=36, that gives us 36 compared to 4=36/4 or a factor of **9 times greater**. We have tripled the aperture, and gained a factor of 9 in image brightness.....a 300% increase in diameter yielding 900% image

2 inch to 10 inch 2x2=4, 10x10=100, 100/4= 25 times greater image brightness!!! You have increased the aperture by 500%, and increased the image brightness by 2500%!!

Now this is where we usually see a major split in the practical size of a scope. When you get above a 10 to 12 inch sized scope, you are pretty much moving into the **BIG LEAGUE**. The sheer size of the scope begins to make it cumbersome to transport, and a scope unused is a bad investment. I guess the lesson here is when considering what size scope to get, remember the best sized scope is **one that gets used!!** continuing, let's see what happens as we increase over a 10 inch scope....

10 to 12=10x10=100, 12x12=144, 100/144= a 44% increase.

10 to 14 = 10x10 = 100; 14x14 = 196, 100/196= 96% image increase. As you can see from these examples, once you get to this sized scope, you have to increase the aperture to a very unmanageable size to get the gains you find with smaller scopes...While we are talking about aperture, there is one factor called the **'f-ratio'** which is helpful to understand. Dividing the focal length of the scope by its aperture yields the **f-ratio.**

There one other benefit of aperture to consider. '**RESOLUTION'. Resolution** is the ability of a scope to separate very close objects visually. For example: A small scope used at a sporting event may show the action quite well, but with a larger aperture, you can see the beads of sweat run down their faces. This factor does work hand in hand with magnification. There is a theoretical limit on the resolution of a scope. It is called the **'Dawes Limit'.** We won't get into the particulars of how it's figured. If you are interested in optics, it is easy enough to find the information. Now you should be able to understand why magnification isn't the end all; it comes down to whether you can see what is there. *Period.*

Clear as mud, right? Well like I said, some people need a little time to just sit down and look at this stuff on paper to get it....

Trust me on this: This all does make sense when you get past the newness of it....

- **Electronics: I've got the 'POWER' or Flying by the seat of your Pants...**

Electronics for your viewing pleasure does bring one into the realm of arm chair viewing. Scope mounted computers can take over the chore of finding objects as well as identifying objects you have found, while **'dual axis drive motors'** automatically track what you have found. Electronic imaging or **'CCD'** is an alternative to **'astrophotography'**. **'CCD'** is short for **'charged couple device'.**

One draw back to all the nice electronics is the dependency on a source for power, not always easy or convenient in the middle of no where. Also, if one suffers a power out, ones viewing can be over for the night.

- **Bells and Whistles: Frills with a price**

This will be the last topic covered under equipment, and there is so much to discuss we just aren't going to go there...suffice it to say, "If you see a piece of equipment you don't understand, ask someone about it!"

Some of the neat stuff that you will see are: **CCD Imagers, Computer Guidance Systems, computerized tracking and slewing features, Digital Setting Circles, Dew Zappers, Hand Warmers, Eyepiece heaters, Photometers, Spectrometers, Pupil Gauges, Night lights, Night Vision Goggles, Polar Axis Finders, Music, Hair Dryers, ----------and the *proverbial* Left-Handed-Wind-Switcher.....!**

Probably the most useful accessories you will find are the Pollution Filters, Colored Filters, and Nebula Filters. These accessories simply screw into the bottom of your ocular, and enhance the detail of objects viewed by increasing contrast.

3. The SKY: The 'Subject' of the Night

A. The Celestial Sphere

- **Arcminutes, and Arcseconds The Clock in the sky**

The sky seems to rotate around the Earth. We know that this is another problem of perspective. It appears this way because the Earth is rotating on its axis making the heavens appear to be moving around us. It takes 24 hours for the Earth to complete one rotation. There are 360 degrees in a circle, so if a star "moves" this 360 degrees around the Earth in 24 hours, we can figure how far the stars will move in an Hour, a minute, or a second....15 degrees in an hour, with 60 minutes to the hour, etc. What this all boils down to is very minute distances to be measured. One **arcsecond** is equal to the width of a penny as seen at 2.5 miles. This relates back to resolution. A 10" scope can see two objects that lie ***half*** this distance apart.

One Degee is equal to 60 arcminutes (60'), or 3600 arcseconds (3600")!

One minute of time is equal to **15 minutes of arc (15'),** and one second of time is equal to **15 seconds of arc (15").**

- **Right Ascension and Declination: 'As the World Turns...'**

On the Earth, we measure our location in **Longitude and Latitude**. On the Celestial Sphere we measure the locations of objects with, you got it, **Right Ascension** and **Declination**. **Right ascension** equates to lines of longitude on the earth measuring east to west positions. As we look further towards the East, the number or **'Hour of Right Ascension'** will increase. This should be easy to remember as this number equates to the order in which the stars rise. One star rising before another will have an earlier value for its Right Ascension. There is no one set spot on the earth to equate to these values as the earth is constantly turning relative to the sky. Although Right Ascension can be measured in degrees, it is commonly measured in Hours, minutes and seconds. Being we are measuring the sky as a ball viewed from the inside, there is some distortion as we move away from the equator. Objects closer to the equator will move a greater distance in the sky than objects towards the poles.

'**Declination'** is measured in degrees, and it is measured from the pole star towards the equator. It measures positions north and south. The pole star is pretty close to 90 degrees. The equator is 0 degrees declination. Degrees of declination are a constant distance of measurement.

- **The Planisphere, Stellar-Scope, and the Star Atlas: Road maps to the Heavens**

Planispheres: This is a simple device which uses the date and time you are viewing to show you where to look to find the various constellations. These are the most essential tools to use in learning the heavens, and every newcomer to astronomy needs to know how to use one. This is the best tool in learning the constellations, and to get a feel for the movement of the sky.

Stellar Scopes: These are fairly new tools which look like kaleidoscopes. They contain a microfiche of the sky housed in a tube which you set to your time and date of viewing not unlike a planisphere. Once oriented, looking thru it will reveal the positions of the stars visible at the time. This is a very useful tool for the newcomer, however it is seldom seen because of it's relative newness and lack of familiarity.

Star Atlas- A star atlas is nothing more than a map of the sky showing the relative position of objects. They are generally very detailed, and not easy to use until some familiarity with the sky is gained. Otherwise, you may find yourself "looking for Moscow in Utah" so to say..... Find an atlas that suits your level of skill. Some beginners find the use of a hybrid atlas more helpful. These atlas' are a cross between an atlas and a star catalogue. They contain not only the positions of the objects, but some pertinent viewing information about the objects listed.

B. Targets in the Sky

- **Visual Impressions: Big Bright, and Textured vs. Dim Faint and Fuzzy**

Forget what you have seen in pictures for the most part. What objects will look like thru a scope will generally not have the detail you are accustomed to seeing in pictures. This has a lot to do with the fact that pictures are generally very long exposures of the heavens with very large equipment. With practice, your eye will gain skill and ability to see faint detail that you will not see at first. This takes time to acquire, and generally the only way you will note the improvement in your eyes is looking back in your **journal** at the descriptions you have written in the past of objects you may view again some time in the future.

Among the prettiest objects to look at initially are **Double Stars**. Looking at these cosmic twins will expose you to the many and varied colors and intensities or **Magnitudes** of the stars, and give your eye training in seeing objects which lie very close together**. Galaxies, Open star cluster, Nebula, the Planets, the Moon, Exploded Stars, and even----------the Sun are waiting for your viewing**. These are just a few of the many Cosmic adventures awaiting you.

- **Time and Distance: The fine Art of catching Photons... They may be OLD, but THEY AIN'T SLOW!!**

The Astonomical Unit (AU): The distance from the Sun to the Earth**, or 93 million miles**

The Speed of Light: **186,000 miles/second** in case you forgot, that's **669,600,000 miles an hour!!**
This is a constant 7.2 AU/hour

The Light Year: The distance traveled by a photon of light in one year **= 5.8 trillion miles, or 63,240 AU**

The Parsec: Roughly **3 light years, a parsec** is best defined as the distance at which an object will show a **'Parallax' of one second of arc.** That's about the diameter of a penny seen at 2.5 miles.

Looking back in Time: The distances to even some of our closest neighbors in the heavens are so great that even at the speed of light, it takes so long for the light image to reach us, that we are realistically seeing the past. to give you an idea of the distances we are speaking of:

Sun- 1 AU., 93,000,000 miles, 8 light minutes
Moon- 250,000 miles 1 1/2 light seconds
Jupiter- 4.2 AU. approx. 35 light minutes.
Alpha Centauri- Our closest star system approx. 4.2 light years
Andromeda Galaxy- Our closest neighboring Galaxy (until recently)
2 1/2 million light years.