

## RASC National : Insider's Guide to the Galaxy Livestream

### Notes for "Beginner Telescopes & Accessories" (YouTube Link [here](#)) by Chris Vaughan, RASC Toronto Centre - May, 2020 (adapted from NOVA course)

WILL cover ... Optical Astronomy Equipment (including terminology, jargon and acronyms)  
WON'T cover ... Astrophotography and Electronic or Video Observing

Good sources of Information are:

Wikipedia

RASC BOG, Observers Handbook, and Website

Astronomy Forums (While there ARE general ideas about what's considered good equipment, there's no single right answer. Everyone's opinion is different, so online forums can be confusing.)

#### About the Presenter... Chris Vaughan (email [cgigeo@rogers.com](mailto:cgigeo@rogers.com))

A Mineral Exploration Geophysicist, amateur astronomer since age 10, some university astrophysics, RASC Member in late 1970's and again since 2011, primary interests are (urban) visual astronomy and public outreach and education. @astrogeoguy on Twitter and blog at [www.astrogeo.ca](http://www.astrogeo.ca)

When working with telescopes outside in daytime...  
**SAFETY NOTE: NEVER POINT A REGULAR TELESCOPE AT OR NEAR THE SUN!**  
(unless it has a proper Solar Filter (already attached))

#### TELESCOPE BASIC PARTS

Nearly all telescopes have the same basic components:

Mount & tripod, OTA (the "tube"), Focuser, (Diagonal), Eyepiece(s), Finder, Tray/Spreader

#### SOME BASICS – LIGHT & OPTICS

The light NOVA's observe is direct and reflected natural light. The visible part of the Spectrum is not the only useful part, but it's the only part we use in V.A. Optical telescopes and binoculars concentrate and focus light via Refraction and Reflection!

#### REFRACTION (Bending)

Transparent materials refract or bend light rays (usually glass). The amount depends on the type of glass and the colour of the light (prisms and rainbows). Convex lenses are just continuous prisms! Refractor Telescopes use lenses to focus/concentrate light and to magnify images. The front lens is called the Objective.

#### REFLECTION (Bouncing)

"Shiny" materials reflect or bounce light rays. The amount depends on the efficiency of mirror (metals, like Aluminium are the best). Curved parabolic mirrors reflect parallel rays to a single focus point. Reflector telescopes (and some other types) use a parabolic mirror to focus and concentrate the light. It's called the Primary Mirror.

#### TELESCOPE "NUMBERS"

Aside from its type (reflector, refractor, etc.), three numbers (parameters) define a telescope. They are: Aperture, Focal Length, and Focal Ratio

#### APERTURE

**(Major Factor for Observing Dim Object Types)**

The more light you can collect, the better. More photons into the eye means brighter images! Aperture is the area of light collection (Primary Mirror or Objective lens size). Traditionally quoted in inches, but nowadays in cm or mm, too. Aperture scales as the square of the diameter of the telescope, so...

8" vs 6" is  $64 \div 36 = 1.75$  times more light gathered!

6" vs 4" is  $36 \div 16 = 2.25$  times more light gathered!

8" vs 4" is  $64 \div 16 = 4$  times more light gathered!

Always buy the biggest aperture you can manage (to carry around) or afford. It's far easier to make and mount a large, good quality mirror than a lens, so the largest telescopes are all reflectors. Also, glass in heavy lenses flows over time (100's of years) due to weight. Plus - Reflector telescopes can be shorter because mirrors can fold the light path! Common affordable amateur refractors are 50mm to 80mm (2" to 3"). Bigger ones get pricey, and too long to be portable! Common affordable amateur reflectors are 115mm to 2030mm (4.5" to 8"), but reflectors remain affordable - even in larger sizes.

### **FOCAL LENGTH (FL)**

#### **(Major Factor for Telescope Length and portability)**

Focal Length is the amount of focussing or bending of the light rays being done by the objective lens or the primary mirror in the telescope. It is defined as the distance from the first optical element to the Focal Point or plane (where the light exits and where your eyepieces are placed). Usually expressed in inches or mm and is written somewhere on the telescope. Simple refractor and reflector telescope tubes are about as long as their Focal Length. Long Focal Length telescopes have a narrower Field of View (imagine looking through a long wrapping paper tube). Short Focal Length telescopes have a wider field of view (now imagine looking through a short length of wrapping paper tube).

### **FOCAL LENGTH IN EYEPIECES**

Eyepieces have lenses, so they have Focal Lengths, too. Labelled on the eyepiece in mm. Eyepieces restore the light rays bent by the telescope back into parallel light rays. The light from the original image has been concentrated from objective size to pupil size.

#### **(An Aside...) FOCUSING**

If a telescope has a certain fixed focal length, why do they need a focuser? Different Eyepieces have varying focal lengths, and not all light entering is from infinity. Focusers move the eyepiece or change the FL.

### **FOCAL RATIO - FR or f/**

#### **(Major Factor whether Objects "fit" eyepiece view)**

The Focal Ratio is defined as the telescope's FL divided by its aperture (Using the same units for both.). It's written as "f/n" where "n" is the ratio's numerical value. If "n" is greater than 8, the scope is considered "slow" and has a narrower FOV. If "n" is less than 6, the scope is considered "fast", has a wider field of view, and is better for astrophotography.

#### **(An Aside...) RESOLUTION or RESOLVING POWER**

Resolution is the ability to see fine, sharp details and to separate close objects (like the famous Double-Double stars called Epsilon Lyrae). Expressed in arc-seconds. Depends on scope's optics quality and larger aperture gives higher resolution (for example, a 6" aperture resolves 0.76' and 8" resolves 0.57'). Often more important than Magnification and it's why observatory scopes keep growing!

### **TELESCOPE BASICS SUMMARY**

**To change any of the above characteristics, you would have to replace the telescope's OTA, or tube. Therefore, it's important to consider those three values when you are shopping. Everything else is covered by the accessories and the mount you attach. Don't buy for the "power"!**

### **MAGNIFICATION**

#### **(Object's image size important to visual observing)**

Eyepieces magnify the image formed at the telescope's Focal Point or plane. Eyepieces are labelled with their focal length in mm. Usually expressed as "times" or "x", like 150x. Also called "power".

Magnification = FL of scope ÷ FL of eyepiece (Units must match, i.e., mm)

Examples:

700mm telescope ÷ 25mm EP = 28X  
1250mm telescope ÷ 10mm EP = 125X  
2000mm telescope ÷ 14mm EP = 143X  
2000mm telescope ÷ 10mm EP = 200X

Higher magnification gives a smaller field of view, so we match the eyepiece to the object. Low eyepiece mm numbers give you high magnification, and vice versa. Use low power for the Moon, Andromeda Galaxy (M31), Milky Way, the Pleiades (M45), etc. Use middle and higher power for planets, planetary nebulae, globular clusters, double stars, and single stars.

### USEFUL MAGNIFICATIONS

Every telescope has a Highest Useful Magnification limit (**HUM**). Magnifying objects more makes them dimmer because the same light is being spread out to make a larger “picture”. Magnifying the image also magnifies the air turbulence we’re looking through, so you see more blurriness. **The HUM is about 2.4 times the aperture in mm, or about 50 times the aperture in inches.** On a good seeing night, 250x is about the limit. On a poor seeing night, only 100-150x is a typical upper limit. (On poor seeing nights, the stars twinkle more – on good seeing nights they’re steadier.) A Telescope’s Lowest Useful Magnification (**LUM**) arises because of “wasted light”. Eyepiece images form a “beam of light” that enters your pupil. The fatter the beam, the brighter the view. Lower power eyepieces have larger openings, so the beam is fatter. If all of the beam doesn’t fit inside your pupil, it’s wasted. Young people’s pupils are about 7mm in darkness, but older people’s are only about 5-6mm. The Lowest Useful Magnification is about 3.6 times the Aperture in inches.

4” telescope, it’s about 14x

6” telescope, it’s about 21x

8” telescope, it’s about 28x

### SUMMARY OF MAGNIFICATION

50x through 200x are typical useable magnifications!

The Moon looks fantastic at 50x to 80x. Planets look fantastic at 150x, and often murky/blurry if pushed higher. Don’t be misled by dramatic magnification (power) numbers in telescope ads or boxes! They mean nothing.

### COATINGS

#### (Another Key to Performance)

Most lenses and mirrors are not perfect - some light penetrates the mirror, and some light reflects off each lens surface. In better quality telescopes and nearly every eyepiece, multiple lenses are stacked together. Each surface is a possible reflection source. So the result is internal light bouncing and a loss of contrast and brightness. Special coatings are used to minimize these reflections and maximize light transmission throughput. They add to the price of equipment, but make a big difference in performance!

### BINOCULARS

Binoculars are twin refractor telescopes rigidly mounted together (or collimated). They have large objective lenses and permanent eyepieces. Internal prisms bring the two light paths to human eye separations and produce a right way up, 3D view. They are inexpensive and portable, usually have a fixed magnification, but some models have zoom capability. Wide field of view compared to telescopes makes them ideal for sweeping star fields or asterisms (like The Coat Hangar) They are described using two numbers, for example 7x35 or 10x50. The second number is the objective lens diameter in mm (the larger, the brighter the image). Telescope aperture rules apply for selecting the size. Look for 40mm and up for astronomy. The first number is the magnification. For astronomy, minimum useful is about 7x. Maximum for handheld is about 10x, but the field of view is smaller.

### BINOCULARS - PRISMS

Roof Prism type are more compact, more expensive, and give somewhat dimmer images (due to more glass in light path). Porro Prism type are larger and heavier.

### BINOCULARS – BUYING TIPS

Look for Barium crown glass lenses (BaK-4) instead of Borosilicate glass (BK7). Look for coated optics throughout for brighter, higher contrast images. Look for central focuser plus a separate focus adjustment on at least one eyepiece. For handhelds, expect to spend between \$100-300 (~\$1000 for image stabilized).

### BINOCULARS – ASTRONOMY USES

Excellent Binocular Targets include the Moon, Jupiter and its moons, Saturn and its rings, Inner planets, The Pleiades (M45), Andromeda Galaxy (M31), Outer planets (from a dark site), Asterisms, and Comets

## TELESCOPE TYPES - REFRACTOR

First telescope type developed (in the 1600's). Galileo's was about 30X. Light path passes straight through. Looking straight through, the image is flipped left-right and up-down, so we add a Diagonal to correct the up-down only (and for a more comfortable viewing angle). An Erecting Prism corrects both (as in a spotting or birding scope). Low-end ones have chromatic aberration caused from different colours focusing at different Focal Lengths, causing colour fringing on the edges of bright objects. High-end Apochromatics (APO) have extra objective lenses to bring all colours to a common focus. Decent, non-computerized low-end refractors cost from \$200 to \$500. High-end Apochromatics can cost several thousand dollars (including a high-end mount). Better lenses allow APO's to have shorter focal lengths and wide FOV, too.

**REFRACTOR – PROS:** 100% of aperture is usable, Simple, Light weight, and portable, Permanently mounted and sealed optics Little to no adjusting or maintenance, Good for Solar System objects, Good for terrestrial viewing, High-end scopes give superior contrast and colour

**REFRACTOR – CONS:** Low price refractor optics are marginal, Good quality scopes are more expensive per inch of aperture than reflectors and other types, Higher apertures require LONG tubes, not practical for casual observing, Less useful for small and faint deep-sky objects due to small apertures. Price goes WAY UP fast with aperture!

**REFRACTOR – MANUFACTURERS:** Department store models – Don't buy them! Look for Meade, Celestron, Orion, etc. for wide range of amateur grade telescopes. Takahashi and Televue for high-end Apochromatic refractors.

## TELESCOPE TYPES - REFLECTOR

First built by Isaac Newton in mid-1600's, a 1.3" aperture f/5. Weren't widely adopted until mid-1700's due to mirror tarnishing. The light path bounces twice. Newtonians have one parabolic Primary mirror and one small flat Secondary mirror at 45 degrees held by a "spider" bracket. The image is not flipped, but can be rotated upside down or to another angle depending on the mount. No Diagonal needed because the secondary mirror at 45 degrees directs the light out the side. The second mirror design allows for a more convenient eyepiece height. Helen Hogg used the DDO 74" scope in a Newtonian configuration. Dobsonian telescopes are large Newtonian reflectors mounted on a swivel base. The Strehl Ratio is a numerical "score" for how accurate a mirror's figure (or curved shape) is. High values yield close to perfect pinpoint stars. Important to professional-grade scopes (& DIYers) Decent, non-computerized low-end ~4" reflectors cost from \$200 to \$600, depending on the mount Good mid-range 6" to 8" Dobsonian reflectors cost \$400 to \$600 while large aperture 10" to 14" Dobs can still cost under \$2,000. Better ones up to ~\$8,000

**REFLECTOR – PROS:** Simple to grind a mirror and assemble (a common ATM project) – inexpensive; Mirror can be designed for a wide FOV; Even very large aperture models can be transported (collapsible truss style); Cost for large aperture models increases gradually (compared to refractors). No chromatic aberration. Excellent for faint objects!

**REFLECTOR – CONS:** Have a central obstruction; Suffer from coma, where off-axis objects produce comet-like images at the edge of the field of view; Sensitive to misalignment if bumped (fixable by collimation); Large ones have limited mounting options; Larger ones need a ladder to reach the eyepiece! Generally not good for terrestrial viewing (owing to non-horizontal images).

**REFLECTOR – MANUFACTURERS:** Department store models – Don't buy them! Look for Meade, Celestron, Explore Scientific, Orion, etc. for wide range of good amateur grade telescopes. Skywatcher and Meade Lightbridge are common larger Dobsonian lines.

**TELESCOPE COLLIMATION:** Ensures that light rays pass through the telescope's optical path squarely. Applies mainly to reflectors and SCTs (containing mirrors). Use defocused star image or laser systems.

**TELESCOPE OPTICS CLEANING:** Refractor Objective lenses are delicate. Only clean when absolutely needed, i.e., never! SCT and MAK correctors can become soiled by dust and pollen, etc. They can be carefully washed (only when needed). The sealed internal mirrors stay clean. **Newtonian mirrors** can be removed and washed

with gentle soap and distilled water. Never rub or scrub them! (Disassembled Newtonian telescopes must be collimated – an advanced process.) Telescope cleaning should only be attempted after extensive research and/or under experienced supervision.

**TELESCOPES & COLD WEATHER:** Allow your telescope to cool down outside to ambient in a secure location (garage, car, deck). Cool down with optics covered - 30 minutes or more for small refractor and open Newtonians, 3 hours for large SCTs (Keep power units warm). After session, cover all optics outside, seal into case, then bring indoors to warm up. Open case to air out after reaching ambient (next morning)

**DEW / FROST CONTROL** for exposed optical surfaces (objective lens, 2nd mirrors, eyepieces, finders). Passive dew shield (commercial or DIY) or active heater straps (need controls, lots of power).

## **FINDERS**

### **(A Major aid to Visual Observing)**

A small optical aid with wide field of view attached to the telescope OTA and co-aligned with it. Some types offer low magnification, some have none. Some types are illuminated, some are not.

## **FINDER SCOPE**

A small, low power refractor telescope with wide field (5x, 7x, etc.); Common on budget telescopes; Crosshairs inside. Centre the object in the cross by moving the telescope; Mounting bracket to adjust and lock the alignment; The view might be flipped depending on the model (can be tricky).

## **RED DOT FINDER**

No magnification – see sky through it; Common on mid-range telescopes. Projects a red dot or bulls-eye onto a window. Put the dot on the object by moving the telescope; Mounting bracket and adjusting knobs to set alignment; Not good for dim objects; The view is correct (convenient); Needs batteries, works in daylight.

## **TELRADES AND KWIKFINDERS**

Projects a calibrated bulls-eye onto a window. Centre the object by moving the telescope OTA; Very easy to use, very popular; Inexpensive (about \$30 to \$50); Clip onto a fixed mounting bracket and adjusting knobs to quickly set alignment; Calibrated bulls-eyes allow star-hopping known distances; The view is correct (convenient); Needs batteries, works in daylight.

## **LASER FINDERS**

Not as popular, partly due to aircraft safety concerns; Expensive (about \$100+); Mounting bracket to set and lock alignment; Aims a visible beam at target (convenient); Needs batteries, poor beam in cold weather; Works only at night

## **ALIGNING FINDERS**

Better done in Daytime (no object drift); Aim telescope at a distant object, centre it in eyepiece, and lock the scope in place. Adjust the finder until the same object is centred in the finder. Swap in stronger eyepieces and repeat to increase accuracy. Best checked every time you plan to observe.

## **TELESCOPE MOUNTS**

### **(A Major factor in Telescope Performance - The sturdier (heavier) the mount, the Better!)**

## **ALT-AZIMUTH MOUNTS**

Simplest and cheapest (common on cheap telescopes); Swivels left-right horizontally and up-down vertically Manual or motor driven; Manual ones may have slow motion controls; Motor driven ones track objects by simultaneous movements in both axes; Dobsonians are Newtonian Reflectors on Alt-Azimuth mounts that you push around (can also be motorized); Many SCTs are on single or dual arm Alt-Azimuth fork mounts.

## **ALT-AZIMUTH - CONS**

Cannot account for object rotation through the sky over time, so not suitable for long exposure Astrophotography. Single fork arm mounts not as stable as dual (A heavy scope will shake/vibrate); Accurate Alt-Az tracking is complicated and expensive to implement well; Fork mounts often cannot point to the zenith when accessorized; Fewer options to adjust equipment balance.

## ALT-AZIMUTH - PROS

Simple – especially in Dobsonians; Eyepiece location is very convenient; Non-motorized ones are inexpensive; No counter-weights needed; Some can be adapted to Equatorial (ETX-90).

## EQUATORIAL MOUNTS

Essentially an Alt-Azimuth mount where the left-right axis is tilted to be parallel to the Earth's axis of rotation; Two directions of motion at right angles to one another - Polar (Right Ascension) and Declination (akin to long and Lat respectively). Dec axis ranges from -90 to +90 (+90 shown, and 0 is the equator); RA axis range is 0 to 24 hours (0 is Vernal Equinox between Pisces and Aquarius.) Available on cheap telescopes and required on professional telescopes (observatories); Manual or motor driven; Manual ones have slow motion hand controls; Polar Axis must be aligned precisely to the Earth's axis for proper tracking! Once aligned and aimed, motor driven ones track objects by rotating only the polar axis one revolution in 24 hours.

## GERMAN EQUATORIAL MOUNT (GEM)

Characterized by an extended Declination axis holding an adjustable counter-weight to balance the telescope and accessories. A second telescope may be installed in place of the weights

## POLAR SCOPE ALIGNING

High-end GEM mounts have a Polar Scope through the RA axis for high-precision aligning. **Not for NOVA!**

## GERMAN EQUATORIAL MOUNT - PROS

Highly accurate tracking with a single motor; Properly matches the rotation of objects (required for long exposure photos); GEM can hold two scopes; Telescope sits closer to the axis than fork mounts, so less flexure/vibration; Versatile for many telescope types; Can be purchased separately and upgraded; Nice and heavy, so stable.

## GERMAN EQUATORIAL MOUNT - CONS

Requires skill and time to set up and align properly; Polar Scope GEMs require complete understand of celestial motions; Good ones are expensive; Eyepiece can end up in awkward positions; Heavy to transport

## EQUATORIAL MOUNT - MANUFACTURERS

Come with some budget telescopes. Low-end amateur ones made by Celestron, Orion, etc. are \$150 to \$250 Good mid-range ones are \$500 to \$1,500. High-end models made by Skywatcher, Celestron, Vixen, Losmandy, and Takahashi are \$2,000 to many thousand dollars.

## EYEPIECES

### (A Major key to Visual Observing)

Eyepieces do most of the job magnifying the image. There is a wide range of sizes, quality, and function. Components are barrel, eyecup, and endcaps.

## EYEPIECE SIZES

There are three "families" of eyepiece barrel sizes:

- 0.965" used on cheap telescopes (If the telescope only takes 0.965" eyepieces, don't buy it!)
- 1.25" used on all better telescopes
- 2" used for low power wide angle views on all better telescopes

A lot of good observing can be done with only 2 or 3 good eyepieces. They should fall into your telescope's useful magnification range. You can use a Barlow lens to multiply your collection!

## EYEPIECES – BARLOW LENSES

A Barlow lens "defocuses" the telescope and effectively doubles (or more) the FL. Most common are x2, but there are others. They can be placed before the diagonal or the eyepiece.

$$1250\text{mm telescope} \div 10\text{mm EP} = 125\text{X}$$
$$2 \times 1250\text{mm telescope} \div 10\text{mm EP} = 250\text{X (Same setup with 2x Barlow)}$$

With only a 10mm and a 30mm eyepiece and a 2x Barlow, you effectively get 5mm, 10mm, 15mm, and 30mm:

2 x 1250mm telescope ÷ 10mm EP = 250X  
1250mm telescope ÷ 10mm EP = 125X  
2 x 1250mm telescope ÷ 30mm EP = 83X  
1250mm telescope ÷ 30mm EP = 41X

Decent Barlow lenses cost about \$40 to \$70. Excellent ones cost about \$150 to \$300. But remember, they reduce the number of eyepieces you need!

### **EYEPIECE - FIELD OF VIEW**

Apparent Field of View (AFOV) is expressed in degrees or minutes of arc. AFOV is provided by the manufacturer and depends on the eyepiece design. The actual FOV you see depends on the magnification (telescope dependent). It's defined as:

$$\text{FOV} = \text{AFOV of Eyepiece} \div \text{Magnification}$$

The Sun and Moon are both about 30 minutes of arc across (30'); Jupiter is between 30 and 50 seconds of arc across (30"-50").

### **COMMON EYEPIECES TYPES**

Ramsden and Huygens are inexpensive 2-lens (2-element) ones and have a narrow AFOV – avoid them (Often come with cheap telescopes); Kellner and Modified Achromat (MA) are 3-element ones with a 40-45 degree AFOV (10mm and 25mm come with good entry level scopes); Orthoscopics are 4-element, good for planets, small 45 degree AFOV; Plossls have 4 or 5 elements, have a 50 degree AFOV, good general purpose – often come as the starter eyepiece in higher-end scopes Erfles have 6 elements, wide 60-65 degree AFOV and comfortable to use. Nagler have up to 8 elements, ultra-wide 82 degree AFOV, expensive higher-end (older); Ethos have 8 elements, ultra-wide 100 degree AFOV, exotic glass, porthole effect (expensive); Delos are modified Ethos with 72 degree AFOV and large eye relief. These are heavy, pricey!

### **EYEPIECE - EYE RELIEF**

Different designs require different eye placement. Eye relief is how far from the lens your eye needs to be. Glasses wearers want more eye relief distance.

### **ZOOM EYEPIECES**

Zoom lenses cover a range of focal lengths, commonly 8-24mm continuously. Good ones made by Baader-Hyperion, Meade, Orion, Televue, etc. Cost \$250-\$500 New (good value).

### **ZOOM EYEPIECES – PROS and CONS**

Excellent for outreach and general purpose observing and fast image resizing; you need to buy fewer EPs.

### **ZOOM EYEPIECES – CONS**

More expensive; Heavier; Mechanical (therefore subject to wear and cold weather); More glass dims image.

### **EYEPIECE MANUFACTURERS**

Televue – excellent, from Plossls ~C\$140 to Delites (62°) ~C\$330, Panoptics (68°) ~C\$330, Delos (72°) ~C\$450; Nagler (82°) ~C\$405, Ethos (100°) ~C\$750; Meade and Celestron full lines; Vixen Lanthanum, Astro-tech Titan, Orion, Explore Scientific (ES), Baader-Hyperion, and more...

### **EYEPIECES - BUYING**

Match your needs to your final telescope; Buy a reputable brand; Research the reviews; Look for quality and undamaged coatings; Look for darkened lens edges to cut stray light; If buying in person, check for obvious damage or any rattling of loose elements; Take care of them – they re-sell well.

### **SPECIALTY EYEPIECES**

Reticule/Reticle eyepieces have internal crosshairs to allow perfect centering of the image (for aligning, collimation, and guiding). Some have illuminated crosshairs.

### **FILTERS**

Filters are designed to remove some wavelengths of light (colours or light pollution) or reduce all light equally (Moon and bright planets). They usually screw onto the eyepiece barrel. New observers don't really need them. Solar filters allow safe Sun viewing.

### **FILTERS – COLOURED**

Colour filters block certain colours of light to enhance planetary details on coloured planets like Mars, Jupiter, and Saturn.

- #8 Light Yellow - Orange and red features on Mars, Jupiter, Saturn
- #11 Yellow-Green - Blue and red features on Jupiter
- #15 Deep Yellow - Improving contrast on moon, blocking blue light
- #21 Orange - Enhancing bands on Jupiter and Saturn
- #23A Light Red - Dust clouds on Mars
- #25 Red - Ice caps and surface of Mars
- #38A Deep Blue - Lunar features and Red Spot on Jupiter
- #47 Violet - Venus and clouds on Mars
- #56 Light Green - Cloud detail on Jupiter and Venus, Mars ice caps
- #58 Green - Martian ice caps, clouds, and dust storms
- #80A Medium Blue - Red Spot and bands on Jupiter
- #82A Pale Blue - Low contrast features on Jupiter and Saturn

### **FILTERS – LUNAR AND PLANETARY**

Neutral Density or Variable Polarizers (VP) reduce all light equally (Moon and bright planets) to reduce glare. VPs can reduce light to 1%, but 15% to 50% is more practical. Useful for both Moon and more extracting detail from brighter planets.

### **FILTERS – DEEP SKY**

Broadband filters are designed to enhance deep sky objects by removing background light due to light pollution or reflected Sunlight (Moonlight, etc.). Nebulae emit certain wavelengths of light more, H-alpha, H-beta, and OIII, so we subtract the rest with Narrowband filters.

### **FILTERS – SOLAR FILTERS (BE CAREFUL!)**

**Unfiltered Sunlight will cook eyeballs & melt telescopes!**

Broadband solar filters (made of Glass or film) are designed to remove all wavelengths to make the Sun dim enough to view safely (Also known as "White light" viewing). Good for any size telescope. **Affix firmly!** The Sun reveals structure in H-alpha light. We subtract the rest in a special solar telescope (e.g., a PST or Solarmax) designed to pass H-alpha only. Tend to be small aperture refractors. (Lunt, Coronado are good)

### **SETTING UP YOUR TELESCOPE**

Get fully familiar with it indoors or in daytime (read the manual). Pick a spot with open views of your targets and good solid ground (decks and docks are not recommended). Out of direct sunlight, let your telescope cool down (leave the eyepiece out) Watch out for birds#%@ and mischief. Before dark, align your finder using a distant landmark. Ensure fresh or fully charged batteries in your telescope and RED flashlight. Plan your attack! (targets). Level your tripod base and align if needed. Have fun!

Always use the longest focal length eyepiece initially. It will show the largest field of view and least amount of magnification – making finding your target easier. Swap in stronger (shorter focal length) eyepieces to magnify the target, if the seeing conditions warrant it.

### **BUYING EQUIPMENT**

If possible, buy from a reputable dealer or manufacturer (both new and used) for service and warranty. If buying privately, try to buy from an Astronomer, especially a club member or someone who has a long standing online presence on forums, etc. or go through an established online service like Astrobuysell.com. Under NAFTA, Amateur Astronomy equipment can be imported to Canada duty free! But HST still applies! Buying used equipment saves a LOT of money! Astronomers are constantly trying out new gear and trading up due to "Aperture Fever". They sell older gear to finance this - it's very normal. Nothing wrong with last year's model for NOVAS if it's been well cared for.



### **BUYING EQUIPMENT - WHAT TO ASK**

Is it brand new? What does it come with? Has it been damaged? (If used or unusually cheap, was it stolen?) What is the warranty? How long is the delivery? Can I trade up later?

### **WHERE TO BUY EQUIPMENT - NEW**

Bricks and Mortar Retailers: Khan Scope (North York); Durham Skies (Pickering); KW Telescopes (Waterloo); New Eyes Old Skies (Richmond Hill); La Maison de l'Astronomie (Montreal), Focus Scientific (Ottawa). Online Only Retailers: CanadianTelescopes.com; Agenaastro.com (USA); Astronomics (USA), etc.

### **WHERE TO BUY EQUIPMENT - USED**

Bricks and Mortar Retailers: Khan Scope (North York); KW Telescopes (Waterloo); New Eyes Old Skies (Richmond Hill); La Maison de l'Astronomie (Montreal). Online Retailers: see above. Online Astronomy Classifieds: Astrobuysell.com; Astromart.com (requires a small fee); Cloudynights.com classifieds and Sell/Swap; Astronomyforum.net classifieds. Online Non-Astronomy Classifieds: Kijiji.ca (GTA); Craigslist.ca (Toronto Craigslist); Ebay.ca (mostly online stores). These are high-risk, high-reward sources! (Use an astronomer friend for help)

### **USED EQUIPMENT - WHAT TO LOOK OUT FOR**

Be careful when taking cash to meet a stranger. Whenever possible, take an astronomer friend (or a regular one). Check for loose or broken parts (gently shake eyepieces). Can the telescope/binos achieve sharp focus – even if only in daytime? Does it operate fully, without unusual grinding or clicking noises?

Please direct questions to [chris.vaughan@astrogeo.ca](mailto:chris.vaughan@astrogeo.ca)