Observation Optimization

The purpose of this presentation is twofold. For the person who already has equipment and an observation site they will be observing most of the time we will identify the appropriate astronomical targets to focus on. For the person who is looking to purchase new equipment we will identify the appropriate equipment for the type of targets they would like to observe.

Types of Objects

For this discussion it is best to classify astronomical targets into three groups:

- **Solar System Objects**: Extremely bright and have an extended surface area.
- **Point Source Objects**: These are objects with a very small surface area and can be considered point sources, or very close to a point source in size. Sizes measured in arcseconds (“).
- **Extended Objects**: Objects have a significant surface area that light is emitting from. Sizes measured in arcminutes (‘).

Object Classifications

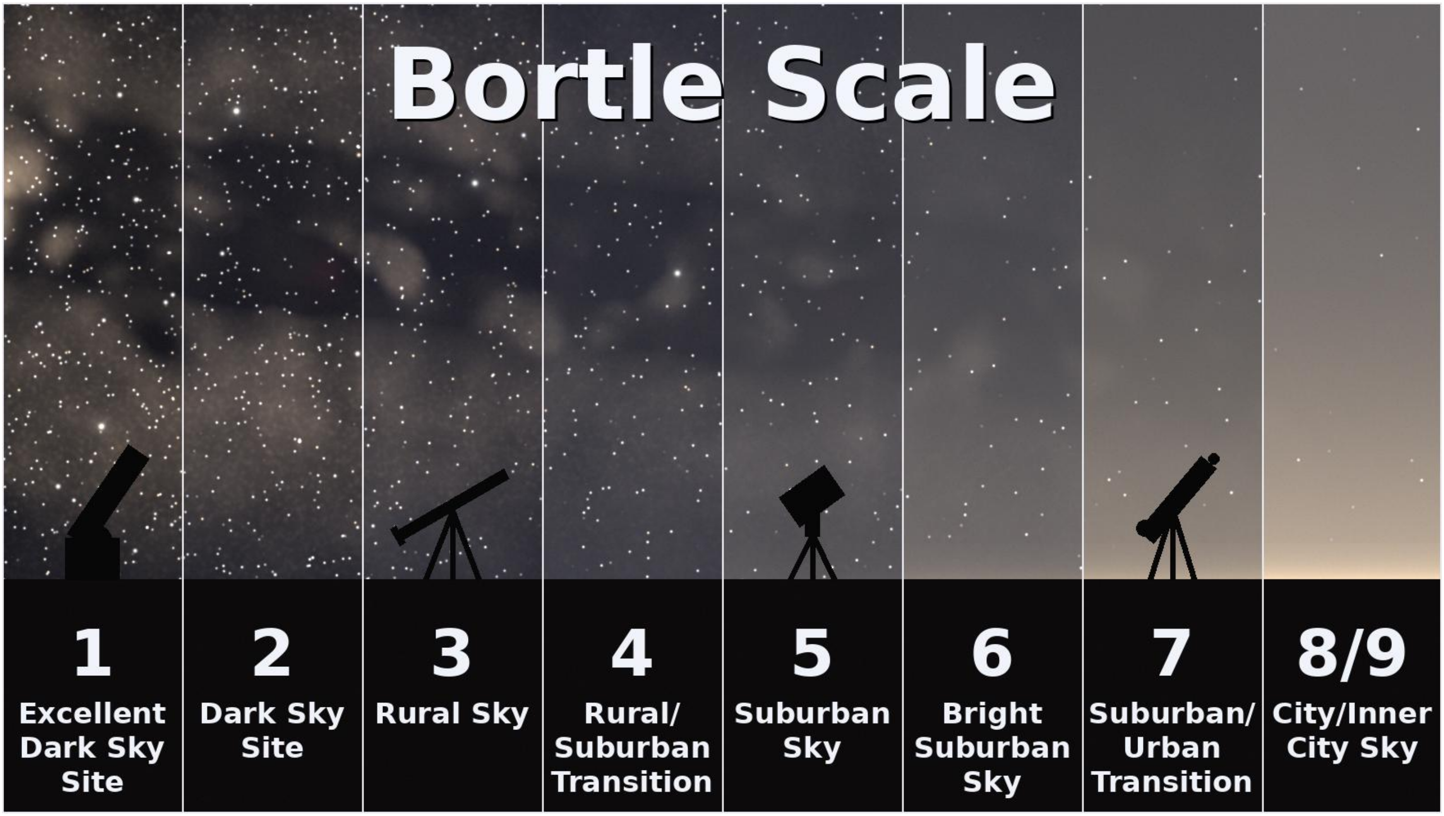
The Table below classifies most of the astronomical objects into the three groups we identified above.

Object Type	**Examples**	**Comments**
Solar System Objects	Sun, Moon, Planets	
<u>Point Sources</u> Carbon Stars, Double/Multiple Stars, *Open Clusters, *Small Planetary Nebulae, Asterisms	Hynde’s Crimson Star (CS) Albireo (DS) Double-Double (MS-4) Butterfly Cluster (OC) Ghost of Jupiter (PN) Stargate (AS)	Open clusters often can be treated more like point sources since they can be composed of a collection of point sources in a given area.
<u>Extended Objects</u> Galaxies, Globular Clusters, Large Planetary Nebula, Dark Nebulae, *Open Clusters, Comets	Whirlpool Galaxy (G) Messier 10 (GC) Helix Nebula (PN) Pipe Nebula (DN)	

Observation Optimization

Contrast

Sky background glow typically can be expressed in units of mag/arcsec^2 a scientifically accurate measurement, but for simplicity most folks use the **Bortle Scale** that describes a range SQM values.



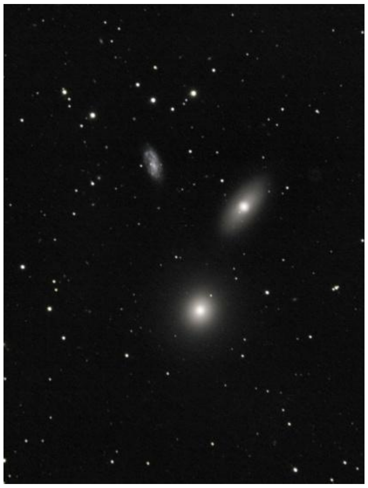
For extended deep sky objects such as galaxies we can estimate the approximate brightness of the object by getting the total light emitted by the object (Magnitude) and divide that by the apparent size of the object. This measurement is called the **Surface Brightness** and its units are the same as the sky background units, mag/arcsec^2. Note this as a very <u>rough</u> estimate. This calculated value gives a uniform brightness value. We all know that this is not the case for most objects. Additionally, different measurements of object sizes are common, depending on who is taking the measurements and what criteria they are using to define the boundaries of an object. Surface Brightness values are similar to Magnitude and Bortle Scale values in that the lower the number the brighter the object.

From the Surface Area calculation we can see the Surface Brightness approaches the Magnitude value as the area of the object shrinks. For Point Source objects, such as stars, the Magnitude value is all that is needed to describe an object since it has a VERY small surface area.

What makes an object visible in a telescope or binoculars is the difference in lightness between the object being viewed (Surface Brightness) and the background sky (Sky Bortle Value). This difference is commonly called **Contrast**. As a general rule, in order for a person to be able to distinguish and object from the background, there needs to be a 0.5 magnitude difference between the two.

Observation Optimization

Why is this important? The sky brightness of where you are observing (Bortle rating) may very well limit what objects you can observe. You will never be able to see a galaxy if the galaxy is dimmer than the background sky.



Bortle 1 – Dark Sky

Bortle 4 - Suburban

Bortle 7 - City

Aperture Size

The aperture size of your telescope impacts a couple of important factors:

- **Resolution** (the ability to see smaller details or separate multiple star systems) Persons with a larger telescope will be able to separate double star systems that are closer together and see more fine details on the moon and planets up to a limit, then the atmospheric starts to become the limiting factor. For telescopes with good optics at about 9.25" the viewing becomes atmospheric limiting, so increasing the aperture probably won't help you resolve double stars, or seeing better details on the moon.
- **Light Gathering Power** directly impacts how bright objects may appear when observing them. There is no practical limit to the benefits of having a larger instrument when it comes to light gathering power. Size really does matter when it comes to dim extended deep sky objects.

Mounts

Mounts really don't impact what you can see when looking at an object. However, the telescope doesn't matter if you can't FIND the object. Darker skies (Bortle 4 or less) are usually dark enough that you can star-hop to targets with pretty good success once you learn the technique. As Bortle increases, star hopping becomes increasingly difficult to the point where in-the-city viewing at Bortle 7 makes star-hopping nearly impossible for even experienced astronomers. So, in-city-viewing usually will mandate either Go-To or Push-To mounts.

Focal Ratio

The Focal Ratio (FR) of a telescope will also have an impact on what objects are appropriate to view. The larger the Focal Ratio (f-ratio) the larger the inherent magnification of a telescope. Remember the magnification is the telescope focal length divided by the eyepiece focal length. Telescopes with higher f-ratio values can use eyepieces with lower focal lengths to obtain the same magnification as a telescope with a shorter focal length. Magnification between different f-Ratio telescopes can be matched by changing the eyepiece focal length since Magnification is based on the Focal length of the telescope divided by the Focal Length of the eyepiece. However very fast telescopes may have trouble finding eyepieces with small enough focal lengths to match the same magnification of some of the slower telescopes.

- High f-Ratio telescopes are preferred when high magnification views are required such as looking at double/multiple star systems, details on a planet or the moon and viewing globular clusters and galaxies.
- Lower f-Ratio telescopes are better suited for looking at larger objects such as open clusters, large nebulae, galaxy clusters and asterisms.

Resources

- https://www.skymaps.com/ - Download the monthly Evening Sky Map.
- ArtCentrics.com Website where you can download free PDF books and guides
  - **Yoders Constellation Guides** (James Yoder) – Standalone guides for each constellation (over 50 completed at this point). Deep dive into the objects residing in the constellation including the most popular and less-known difficult objects.
  - **Star Hopper's Guide to the Universe** (Jim Mazur) – A great Star-Hop book that contains a wide range of objects, generally the best/most popular objects in a given constellation.
  - **A New Catalog of Stellar Richfields for Binoculars** (Bill Dellinges) – Tailored for binocular astronomy.

Making a Decision

Please keep in mind, these are guidelines, and there will always be exceptions we can find for each scenario, for instance M-42 a nebula and open cluster, still look good in the city even in a small telescope. Just because a telescope design may not be listed in a certain scenario doesn't mean it can't be used, it just may not be optimal for that class of targets. Many experienced astronomers may disagree with some aspect of the table below; make your own judgement based on further research or your experience.

- Already own a telescope - Determine what type of targets are best for viewing for by finding the row that matches your Sky Conditions and Telescope Design and reviewing the contents of the corresponding Target Types.
- Looking for a Telescope – Find the Telescope Design that corresponds to the Sky Conditions and Astronomical Target Types you are most interested in observing.

Observation Optimization

Lookup Table

Sky Conditions	**Astronomical Target Types**	**Optimal Telescope Designs**
Darker Site Viewing (Bortle 1-4) Increasing Aperture will always help in these conditions	Solar System Objects, Double/Multiple Stars, Small Planetary Nebulae	High f-Ratio Telescopes • Maksutov-Cassegrain (Best) • Schmidt-Cassegrain • Dobsonian
Darker Site Viewing (Bortle 1-4) Increasing Aperture will always help in these conditions	Galaxies, Nebulae, Dark Nebulae, Large Planetary Nebula, Open Clusters, Globular Clusters	Large Aperture Telescope • Dobsonian (Best) • Schmidt-Cassegrain
Darker Site Viewing (Bortle 1-4) Increasing Aperture will always help in these conditions	Dark Nebulae, Large Planetary Nebulae, Open Clusters	Low f-Ratio Telescopes • Refractors • Dobsonian • Binoculars • Schmidt-Cassegrain
City Viewing (Bortle 5-8) Larger apertures have less of an impact	~~Galaxies~~, ~~Nebulae~~, ~~Dark Nebulae~~, ~~Large Planetary Nebulae~~, ~~*Open Clusters~~, ~~Globular Clusters~~	No point in trying to view most of these objects in the city
City Viewing (Bortle 5-8) Larger apertures have less of an impact	Solar System Objects, Double/Multiple Stars, Small Planetary Nebulae, *Open Clusters	High f-Ratio Telescopes