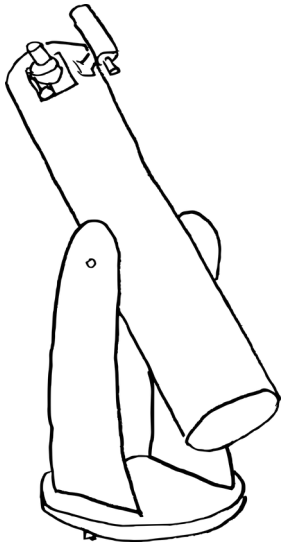
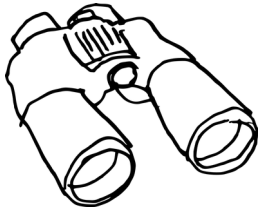
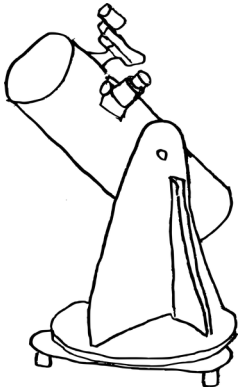
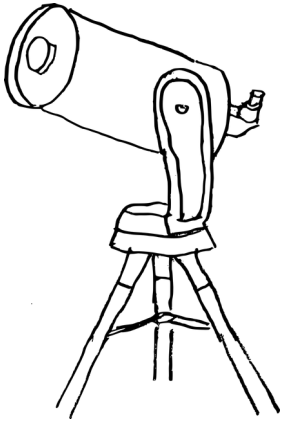
Visual Telescope Buying Guide

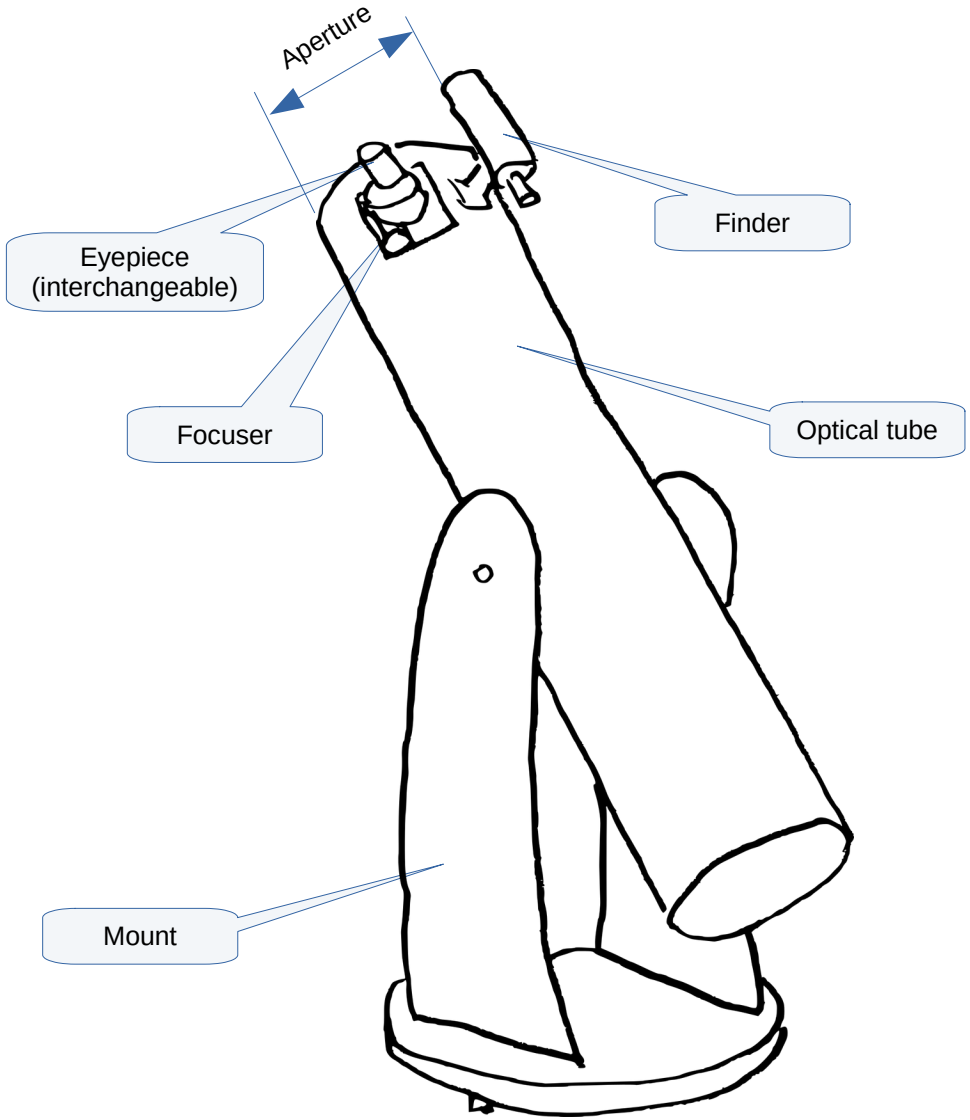
By Emile Cormier

With feedback from members of the
Royal Astronomical Society of Canada, New Brunswick Centre

This guide is intentionally vendor-neutral and does not recommend any specific brands or models. This guide focuses on telescopes that allow direct visual viewing.

Version 2.1, 2025-04-20
This guide can be downloaded for free at https://rascnb.ca/telescope-buying-guide

Telescope Basics



Aperture: Diameter of the objective lens or primary mirror

It is the main performance indicator of any telescope.

More aperture means:

- More light gathering power.
- Faint objects (galaxies, nebulas) are brighter.
- More magnification possible to see finer details (limited by atmospheric conditions – see below).
- Narrower fields of view.
- A bulkier, heavier, and more costly instrument.

How much aperture? It depends on:

- Your budget.
- Your desired portability.
- Your desired performance.
- Your desired field of view range (wide vs. narrow).

Magnification: Ratio between apparent size and true size

Also called “power”. It is determined by the *focal length* of the telescope and the eyepiece that’s being used (eyepieces are interchangeable). It is fixed in most binoculars.

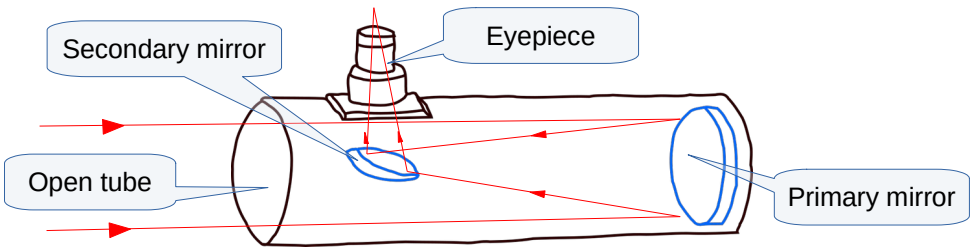
Magnification is limited by one of two factors:

- The telescope’s aperture: ×50 per inch of aperture.
- The steadiness of the atmosphere (called *seeing*).

Atmospheric seeing depends on your climate and geography, but it generally limits useful magnification to around ×200 on most nights.

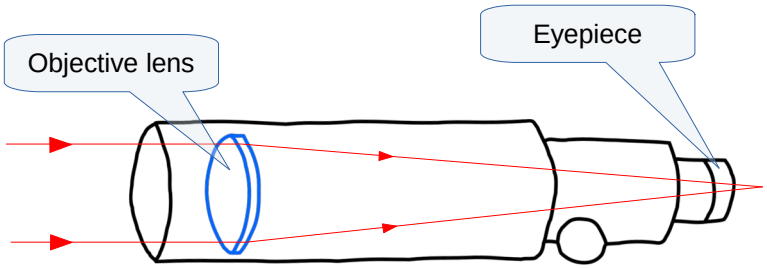
Common Optical Tube Types

Reflector (aka Newtonian)



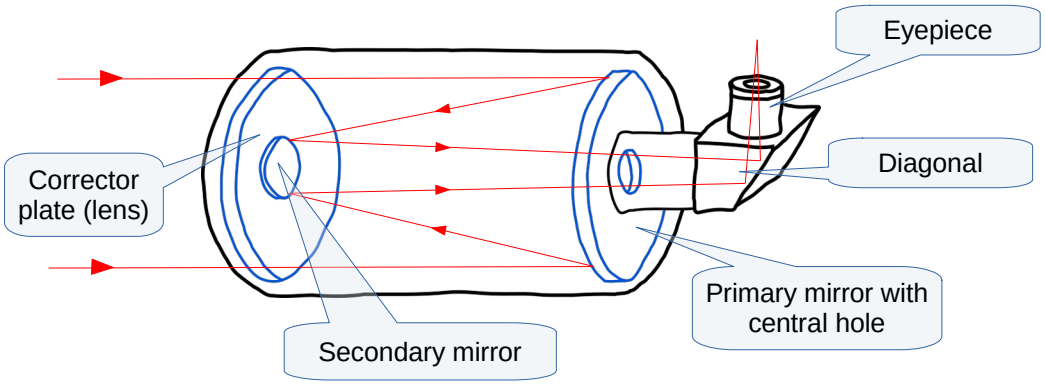
- One looks through the *side* of the tube with this type, not the back.
- Quite affordable when bundled with a simple *Dobsonian* mount
- Less prone to dew than other types
- Requires occasional *collimation* (re-alignment of the mirrors)
  - A *laser collimator* tool makes this quick and easy.
  - Astronomy clubs can do this for free at their meetings.

Refractor



- Limited to smaller apertures (large ones are very expensive)
- Maintenance-free – no collimation required
- *Achromatic* refractors show discoloration of bright objects at high magnification (called *chromatic aberration*) – best used at low power.
- *Apochromatic* refractors show no discoloration but are more expensive – this is the most recommended refractor type for deep sky astrophotography.
- Makes a good portable “grab & go” telescope when paired with an *altazimuth* mount
- Mass-produced kits have flimsy mounts & lousy accessories. Best to purchase the mount & accessories separately. Seek recommendations from experienced observers.
- Also good for terrestrial and solar viewing with proper accessories

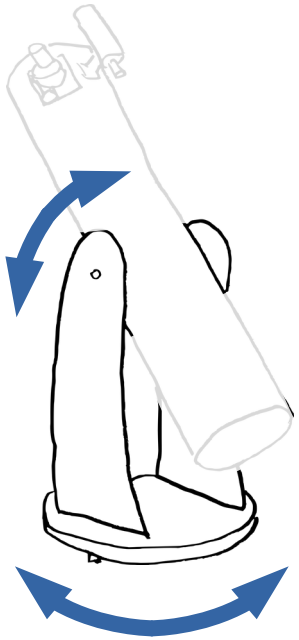
Schmidt-Cassegrain (aka SCT)



- Optical design combines lenses and mirrors
- More compact than a reflector of the same aperture, but also more expensive
- Usually bundled with a computerized mount in telescope kits
- Field of view is narrower than other types – makes it difficult to obtain good deep sky imaging results. Choose an apochromatic refractor instead for deep sky imaging.
- Good for planetary/lunar imaging using specialized cameras and processing techniques
- Best compromise for both visual and imaging, but not particularly well-suited wide-field deep sky imaging

Common Mount Types

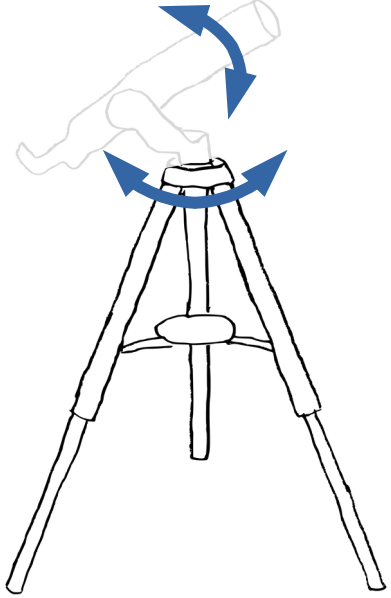
Dobsonian



- Simple wooden box
- Simple left-right / up-down motions
- Always bundled with *reflector* optical tube
- Very cost-effective
- Not very portable

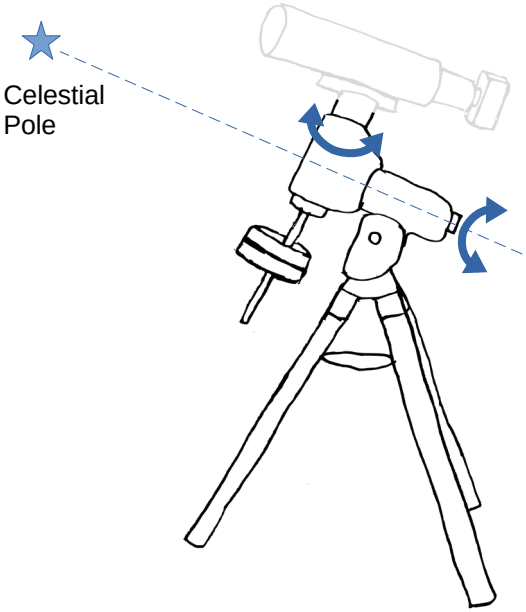
MOST RECOMMENDED FOR BEGINNERS

Altazimuth



- Simple left-right / up-down motions
- Folds down for compact transportation
- Some include *slow-motion controls* to aid in tracking objects
- Those bundled in telescope kits are usually inadequate – better to buy components separately. Seek recommendations from experienced observers.
- A Dobsonian mount is cheaper for telescope apertures larger than 4 inches

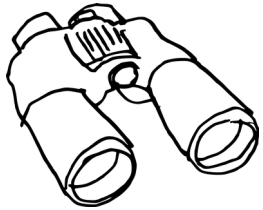
German Equatorial



- Axes of rotation are relative to the *celestial pole* for better tracking
- Motions are not intuitive
- This is the mount type required for long-exposure deep sky astrophotography
- Requires polar alignment for accurate tracking in astrophotograhy
- Those bundled in cheap telescope kits are almost always inadequate.
- Does not pair well with *reflector* tubes for visual use – eyepiece ends up in awkward positions

Telescopes for under $1500 (CAD)

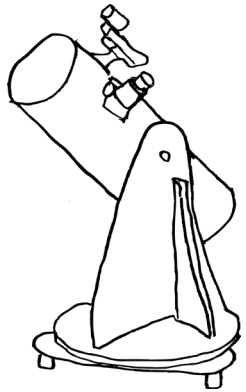
Binoculars



Price: < $250
Complexity: Trivial
Portable: Extremely
Field of view: Very wide
Aperture: 42 - 80mm

- 10×50s are the max for handheld use; 8×42s are easier to hold steady.
- Powers above ×10 need tripod mount for stability
  - Camera tripod can work, video and spotting scope tripods are better
  - Need binocular mounting L-bracket (sold separately)
- Some people can't merge left/right images. Borrow a good working pair if you've never tried.
- **Lowest cost for observing the night skies**

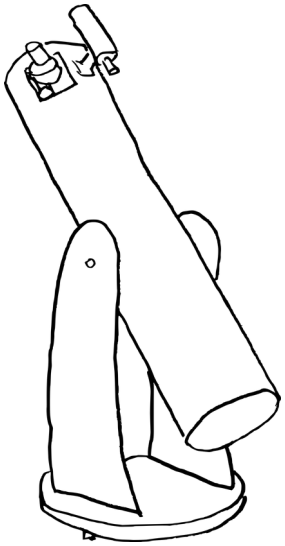
Tabletop Dobsonian (reflector)



Price: Starts at $380
Complexity: Simple
Portable: Very
Field of view: Very wide
Aperture: 4.5 - 5 inches

- Requires table or stool – the sturdier the better
- Avoid spherical mirrors – only buy parabolic.
- Prefer closed tube models (or make a shroud).
- Makes a good "grab & go" scope
- **Better than department store telescopes for those on a tight budget**

Dobsonian-Mounted Reflector (aka Dobsonian)

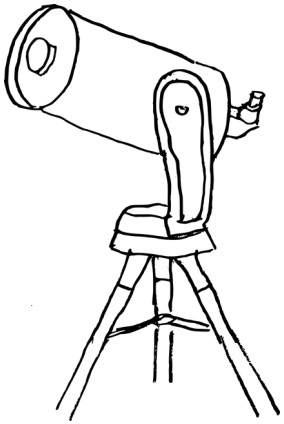


Price: Starts at $640
Complexity: Simple
Portable: Not very
Field of view: Wide
Aperture: 6 - 10 inches

MOST RECOMMENDED FOR BEGINNERS

- Most light gathering bang per buck
- Good for deep sky objects and planets
- Adjustable-height chair recommended
- **8" dobsonian is a good place to start.**

Computerized Single-Arm Schmidt-Cassegrain



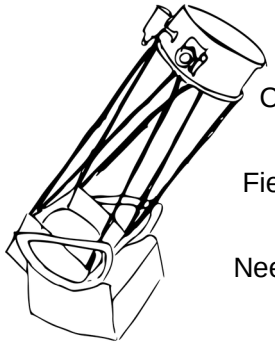
Price: Starts at $940
Complexity: Intermediate
Portable: Quite
Field of view: Narrower
Aperture: 4 - 8 inches

- Mount head moves to track objects.
- Needs star alignment at every setup
- Good for planetary imaging (with specialized camera and processing techniques)
- Deep sky imaging possible with additional wedge, but results may be disappointing
- **Balances portability with performance while featuring go-to capability**

Avoid department store telescopes; they will end up gathering more dust than photons.

Telescopes for over $1000 (CAD)

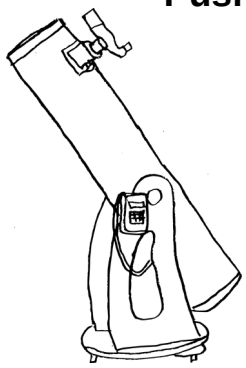
Truss Tube Dobsonian



Price: Starts at $1570
Complexity: Fairly simple
Portable: Not very
Field of view: Wide
Aperture: 10 - 20 inches
Needs power: No
Go-to: No

- More set-up time vs solid tube
- Needs collimation more often vs solid tube
- Shroud covering truss poles is recommended.
- **More compact for travel vs solid tube**

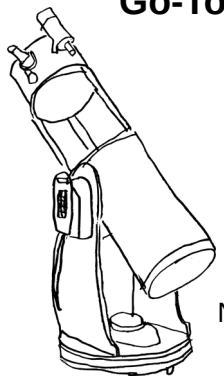
Push-To Dobsonian



Price: Starts at $1100
Complexity: Fairly simple
Portable: Not very
Field of view: Wide
Aperture: 8 - 12 inches
Needs power: No
Go-to: No

- Phone can be attached to guide user where to push tube to find objects
- No motors or gears that can fail
- **Good for urban use where star-hopping is not possible**

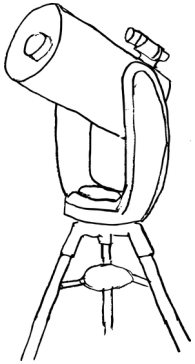
Go-To Dobsonian



Price: Starts at $2000
Complexity: Intermediate
Portable: Not very
Field of view: Wide
Aperture: 8 - 16 inches
Needs power: Yes
Go-to: Yes

- Needs star alignment at every setup
- Good for planetary imaging
- No deep sky imaging
- **Lowest cost go-to for medium aperture**

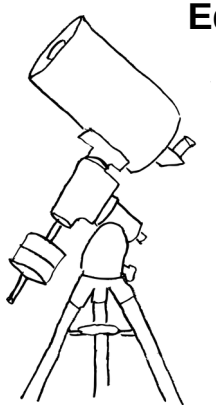
Fork-Mount Schmidt-Cassegrain



Price: Starts at $3600
Complexity: Intermediate
Portable: Depends
Field of view: Narrower
Aperture: 8 - 16 inches
Needs power: Yes
Go-to: Yes

- Needs star alignment at every setup
- Good for planetary imaging
- Deep sky imaging possible with additional *wedge*, but results may be disappointing
- Larger models are quite heavy.
- Cannot use other optical tubes with mount.
- **Balances aperture, portability, and set-up time while providing go-to ability**

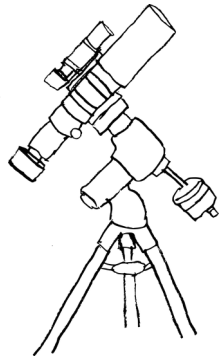
Schmidt-Cassegrain on Equatorial Mount



Price: Starts at $2400
Complexity: Advanced
Portable: Somewhat
Field of view: Narrower
Aperture: 6 - 16 inches
Needs power: Yes
Go-to: Yes

- Needs star alignment at every setup
- Needs polar alignment at every setup
- Good for planetary imaging
- Deep sky imaging possible, but challenging
- Can use other optical tubes with mount
- **Best compromise for both visual/imaging**

Apochromatic Refractor on Equatorial Mount (for imaging)

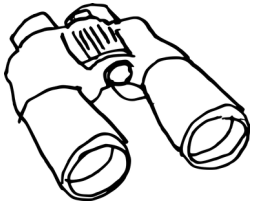


Price: At least $2500
Complexity: Advanced
Portable: Quite
Field of view: Very wide
Aperture: 3 - 5 inches
Needs power: Yes
Go-to: Yes

- Needs star alignment at every setup
- Needs polar alignment at every setup
- 80mm is a good place to start.
- Not enough aperture for planetary imaging
- Can use other optical tubes with mount
- **Ideal for deep sky imaging** – short focal length is more forgiving

Which Telescope Under $1500 is Right for Me?

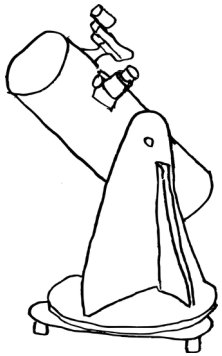
Binoculars



I want:

- ✓ To spend less than $250.
- ✓ A portable grab & go instrument.
- ✓ A simple instrument.
- ✓ To find objects myself using charts.
- ✓ To learn the night sky before buying a telescope.

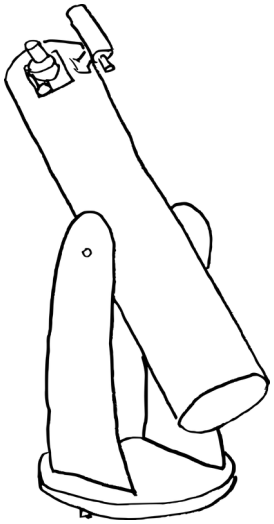
Tabletop Dobsonian



I want:

- ✓ To spend less than $600.
- ✓ A gift for my child (or myself).
- ✓ A portable grab & go instrument.
- ✓ A simple instrument.
- ✓ To find objects myself using charts or attach my phone for push-to guidance.

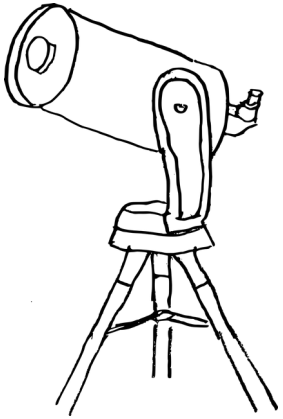
Dobsonian-Mounted Reflector



I want:

- ✓ Lots of aperture for my money.
- ✓ To observe planets in detail.
- ✓ To observe faint deep sky objects.
- ✓ A simple instrument.
- ✓ To find objects myself using charts.

Computerized Single-Arm Schmidt-Cassegrain

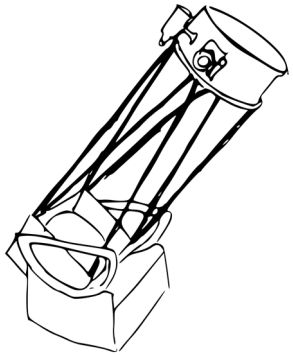


I want:

- ✓ A tripod-mounted portable instrument.
- ✓ A compact optical tube with decent aperture.
- ✓ A fairly technical instrument.
- ✓ Go-to capability and tracking.
- ✓ To observe planets in detail.
- ✓ To observe faint deep sky objects.

There's no perfect telescope; every type trades off certain aspects differently.

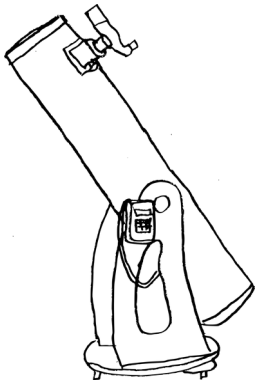
Which Telescope Over $1000 is Right for Me?



Truss Tube Dobsonian

I want:

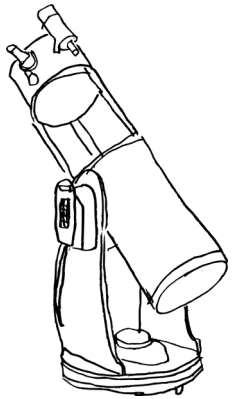
- ✓ Lots of aperture for my money.
- ✓ A simple visual instrument.
- ✓ To find objects myself using charts.
- ✓ A large dobsonian that breaks down into smaller pieces for transport.



Push-To Dobsonian

I want:

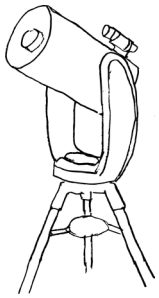
- ✓ Lots of aperture for my money.
- ✓ A simple visual instrument.
- ✓ To attach my phone to find objects.
- ✓ A way to find objects in light-polluted skies.
- ✓ An instrument without motors or gears that can break down.



Go-To Dobsonian

I want:

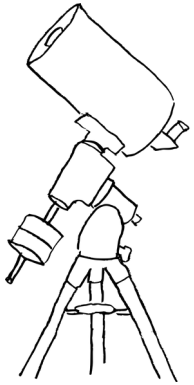
- ✓ Lots of aperture for my money.
- ✓ A fairly technical visual instrument.
- ✓ Go-to capability and tracking.
- ✓ To take planetary images.



Fork-Mount Schmidt-Cassegrain

I want:

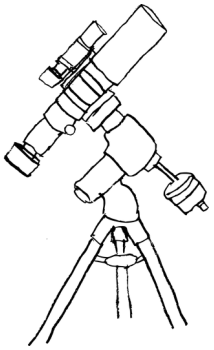
- ✓ A fairly technical visual instrument.
- ✓ Go-to capability and tracking.
- ✓ A tripod and a compact optical tube.
- ✓ To take planetary images.
- ✓ More aperture and stability than a single-arm altazimuth mount.



Schmidt-Cassegrain on Equatorial Mount

I want:

- ✓ A very technical instrument.
- ✓ A mount for visual and imaging use.
- ✓ A compact optical tube for visual use.
- ✓ To spend more time setting up (or house it in an observatory).
- ✓ Go-to capability and tracking.
- ✓ To take planetary images.
- ✓ To dabble in deep sky imaging*****.



Apochromatic Refractor On Equatorial Mount

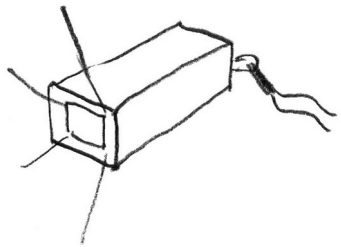
I want:

- ✓ To take long-exposure deep sky images with results I can be proud of.
- ✓ A very technical instrument.
- ✓ A mount for visual and imaging use.
- ✓ To spend more time setting up (or house it in an observatory).
- ✓ Go-to capability and tracking.

***** *Schmidt-Cassegrains have narrow fields of view, so it's much more difficult to achieve good deep sky imaging results. An apochromatic refractor is recommended for deep sky astrophotography novices.*

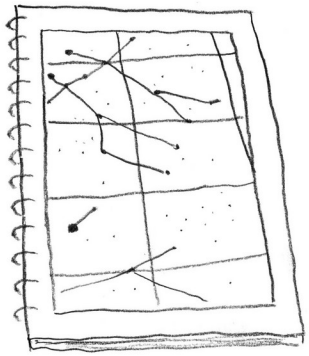
Useful Upgrades and Accessories

Red Flashlight or Headlamp (essential)



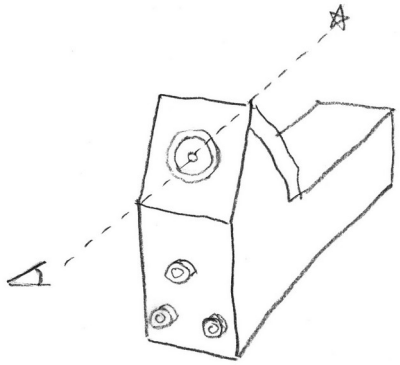
- Preserves dark-adaptation
- Dimmable is better
- Those with lanyards to wear around your neck can free your hands.
- Can dim with layers of tape/paper

Star Charts and Atlases



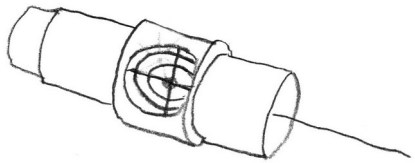
- Essential for manual telescopes
- More reliable than mobile apps
- Some show *Telrad* reticles for bright objects (aka *Telrad charts*).

Reticle Finder



- Projects illuminated circles that measure angular distance.
- Used to find objects at known angular distance from stars.
- *Telrad* and *Rigel Quikfinder* are most common.

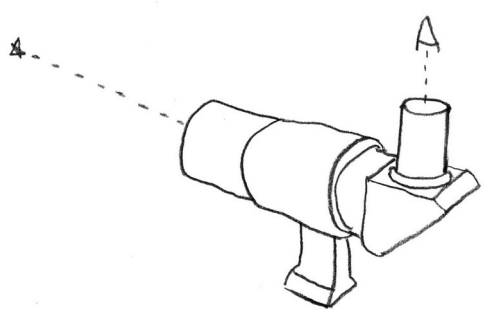
Laser Collimator (for reflector telescopes)



- Easiest way to realign reflector mirrors yourself
- Inserts into focuser drawtube (where eyepiece normally goes)
- Cheap ones are not always accurate.

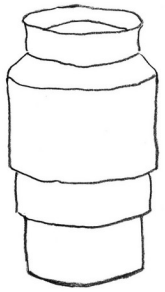
More Useful Upgrades and Accessories

Right-Angle Correcting Image (RACI) Finderscope



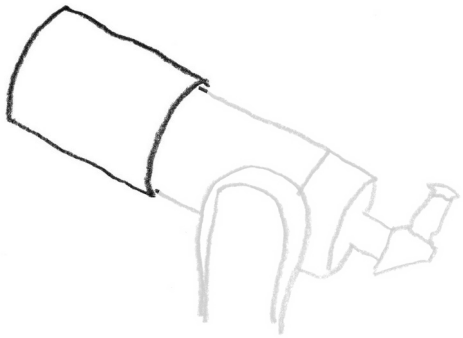
- Less magnified view than main optical tube – easier to find objects
- Right-angle allows comfortable viewing.
- Correcting image matches orientation of the object in the sky.

Wide Angle Eyepiece



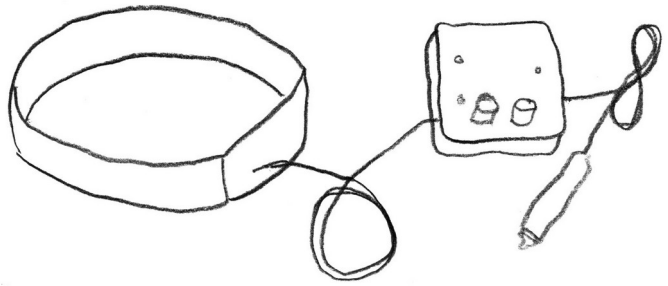
- Useful for very wide objects
- “Spaceship porthole”-like experience
- Makes it easier to find objects before switching to higher power.
- Get recommendations for your specific telescope from experienced observers before buying.

Dew Shield (for Schmidt-Cassegrain Telescopes)



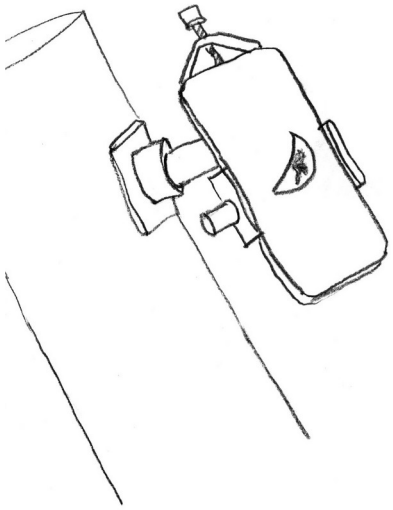
- Wraps around end of optical tube to make objective lens less exposed
- Prolongs time before front lens gets covered in dew
- Can be made at home with suitably flexible and rigid material

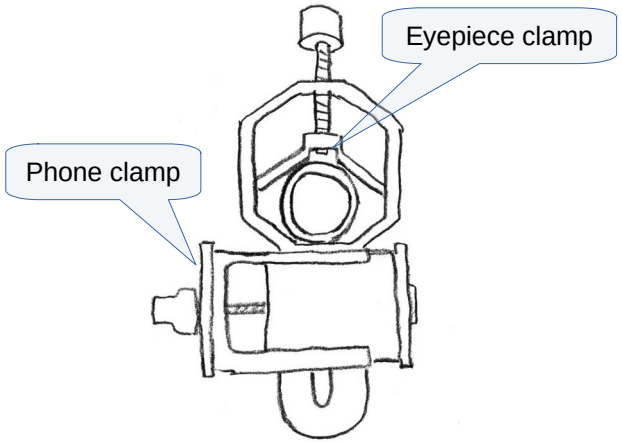
Dew Heaters



- Heated hook-and-loop straps that apply gentle heat
- Prevent lenses and mirrors from getting covered in dew
- Require a *dew controller* and power source
- Never wipe dew off optics!

Gear for Taking Snapshots of the Moon



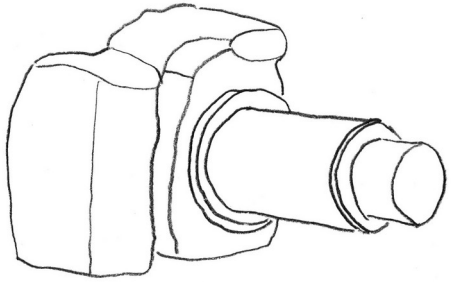


Phone Adapter

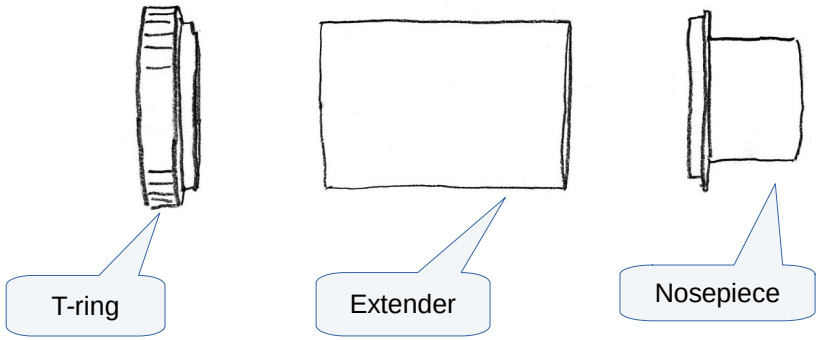
The Moon is the **only** nighttime celestial object that's bright and wide enough to be photographed as a **single snapshot** and produce satisfying results.

Just about any decent telescope will allow you to take snapshots of the moon.

A *phone adapter* makes it easier to hold up and aim a phone camera against a telescope eyepiece.



Camera Adapter

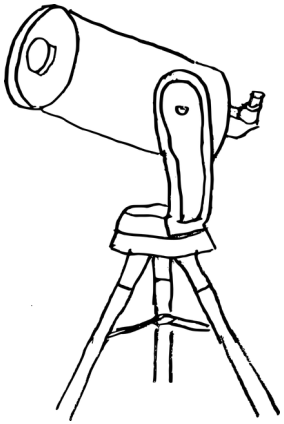


Prime focus astrophotography (without a camera lens) using a digital camera requires:

- A camera *t-ring adapter*.
- Possibly a *t-thread extender* (sometimes combined with the nosepiece) – needed to achieve the required *backfocus* distance on certain Newtonian or refractor telescopes.
- A *t-thread nosepiece* for Newtonian and refractor telescopes.
- *A t-thread to SCT adapter* for Schmidt-Cassegrain telescopes.

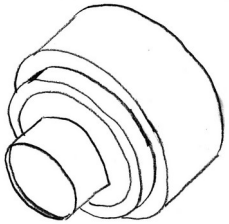
There are camera adapter kits that combine the above. For Newtonian and refractor telescopes, make sure the nosepiece fits into your telescope's focuser (1.25 inch or 2 inch barrel diameter).

Gear for Capturing Images of the Planets and Close-ups of the Moon



Any Telescope with Tracking

+



Planetary Imaging Camera

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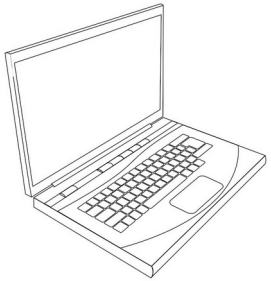


Portable Computer

Due to turbulence in the atmosphere, still images of planets tend to be quite blurry.

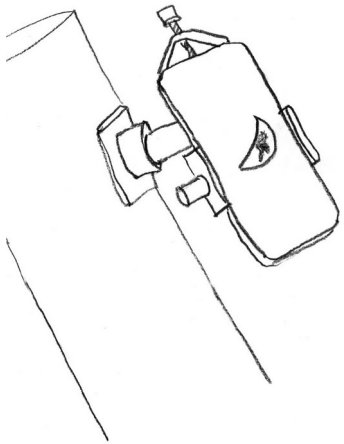
Sharper details are achievable using a process called *lucky imaging*. This involves recording video of a planet through a telescope. The idea is to capture brief moments where the view is steady.

The ideal camera for this is a dedicated *planetary imaging camera* with a high-speed USB 3 output. It requires a portable computer to record the video data (ideally one equipped with a solid state drive). Good cameras cost over $200.

Specialized *stacking* software is required to process the best frames from the video and produce a still image. This image is then digitally sharpened to obtain a much clearer view of the planet than is possible with a single snapshot.

A motorized telescope is pretty much required for this. The more aperture, the better.

Planetary imaging is not a casual endeavour! It's not as simple as point and shoot.

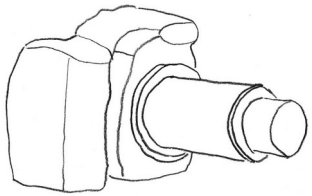


Although less ideal, a smartphone mounted to the telescope via a phone adapter can also be used to record the video of a planet.

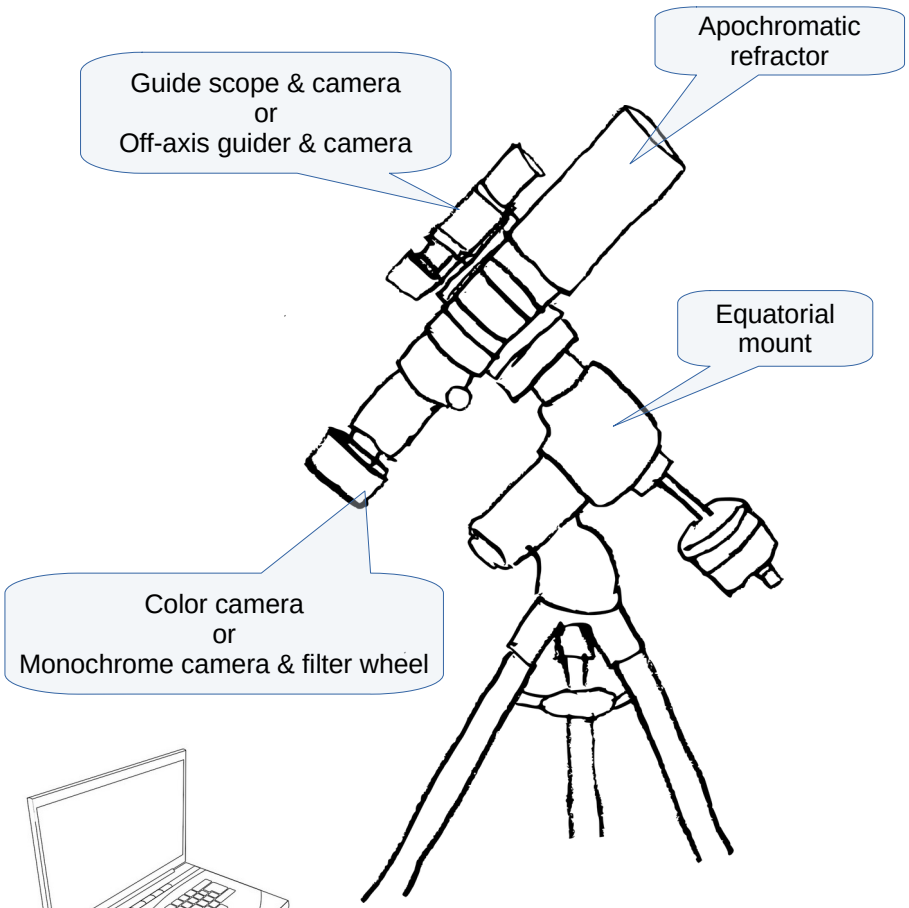
The phone's video then needs to be converted to a format supported by stacking software.

A digital camera (DSLR or mirrorless) can also be used to record the planetary video (in movie mode). It's not as ideal as a dedicated planetary imaging camera, but it can still allow you to try your hand at lucky imaging.

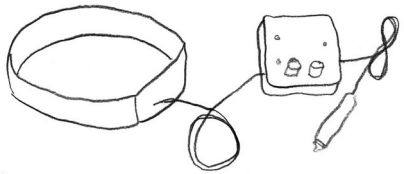
There are programs that can record the video from a digital camera tethered to a computer via USB.



Gear for Capturing Images of Deep Sky Objects with Optical Telescopes



Portable Computer



Dew Heater

Prepare to spend several thousand for a minimal setup.
Much learning effort – not a casual endeavour!

Only a brief overview is provided here. This is a vast subject that cannot be adequately covered in this short guide.

Imaging deep sky objects (galaxies, nebulas, star clusters) involves taking minutes-long exposures using a telescope with good tracking. Hours worth of exposures are required, then need to be *stacked* using specialized software. This can be quite technical and is not a casual endeavour!

A short focal length refractor is the best way to start and achieve satisfying results. Avoid the temptation to use a large aperture instrument such as a Schmidt-Cassegrain – that way will most likely lead to frustration.

Mount options:

- German equatorial mount*:* best option for accurate tracking. Payload capacity should be twice the actual payload weight for mass-produced mounts.
- Fork mount with equatorial wedge: not recommended.

Main camera options (least to most expensive):

- Digital camera body (DSLR or mirrorless) with adapters
- Dedicated *one-shot color* (OSC) astronomy camera
- Dedicated monochrome astronomy camera with filter wheel. More efficient at gathering light and allows *narrowband imaging*.

If you don't already own a digital camera (such as a DSLR), it's better to start with a dedicated astronomy camera if you can afford it.

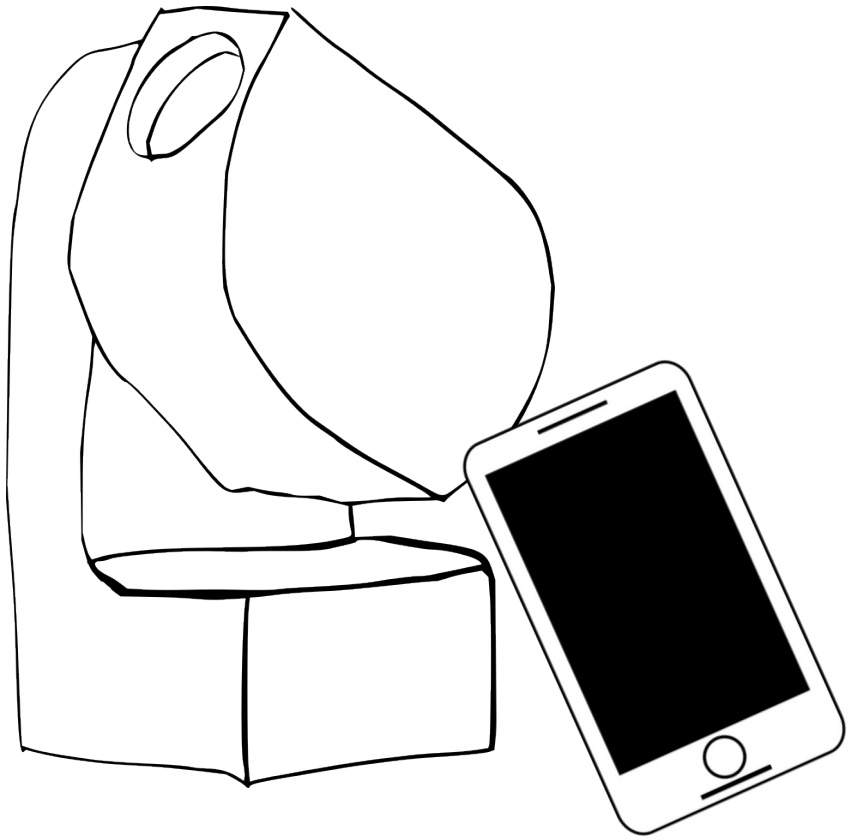
Auto-guiding is recommended for best results. A separate guide camera and special software is used to send corrections to the mount to keep an object centered.

Guider options (requires dedicated guide camera):

- Smaller guidescope mounted to the main scope.
- Off-axis guider (OAG) – uses part of main scope's light.

A portable computer is necessary if using a dedicated astronomy camera, or for running autoguiding software. This can be a laptop, a Raspberry Pi, a stick computer, or a mini computer box made especially for astrophotography capture.

Smart Telescopes: New breed of telescopes for electronically-aided astronomy



- Phone or tablet needed to operate the telescope and view images.
- Telescope finds objects automatically after an initial calibration.
- Images for deep sky objects appear in minutes. Image quality improves over time as it gathers more light from the target and performs *live stacking*.
- Field of view is wide.
- Far easier and quicker to set up and operate than “imaging rigs” made up of several components, but cannot match the image quality of such rigs.
- Images will not be “magazine” publishing quality except for the most expensive models with manual image processing.
- Some include an electronic eyepiece to simulate looking through a purely optical telescope.
- Brightness and colour of deep sky objects surpasses what can be seen in a visual telescope.
- Cannot match the high-magnification details of planets and moon craters seen through visual telescopes.
- For some, viewing a computer-enhanced image on a screen does not match the feeling of reaching out and touching the cosmos when observing through a visual telescope. For others, it makes the cosmos more accessible to them.
- Prices range from just under $600 for small aperture, to over $5000 for larger apertures.