

STARS RESOURCES

Teacher notes

Astrophotography with your Dobsonian telescope and Smartphone camera adapter

ACTIVITY

With your Dobsonian telescope and Smartphone camera adapter it is possible to capture some remarkable images of celestial objects including the Moon, nebulas and binary stars with your upper primary to middle secondary students.

These teacher notes will:

- Give you a basic understanding of how to use the telescope and Smartphone camera to take photos of large objects.
- Set out the limits of what is possible with a small Dobsonian telescope, a Smartphone and affordable or free software.

Four astrophotography activities have been provided for upper primary/lower secondary and middle secondary students in separate documents.

NOTE: Some activities require (free) non-standard software. In many cases, schools will not allow these programs to be installed without administrator rights, or without being approved. It is suggested that you investigate whether or not these programs can be used before committing to the activities.

BACKGROUND INFORMATION

Understanding your Dobsonian telescope

Your telescope is great at collecting light, which is useful if you want to take photographs of celestial objects. However:

1. Dobsonians do not track objects as they move across the sky. You must manually readjust the telescope every few minutes in order to keep objects within the field of vision.
2. Most objects in the sky don't emit much light (the Moon is an exception). Even with the telescope, photos will be faint or fuzzy. This can be overcome by 'exposing' your smartphone's camera to the object of interest for lengthy periods of time. By lengthy, it may be upwards of minutes.
3. The combination of needing to take long photos and the inability of the Dobsonian to follow the object poses an issue.

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BACKGROUND INFORMATION cont'd

The solution?

1. Manually take multiple photos of the same object, resetting the telescope each time, and then add those photos together in software.
2. Shoot a short video on the object then use software to extract single images and stack them.

It is tempting to buy higher magnification lenses (eyepieces) in order to take clearer, closer photos of your object. The flip side of doing this is that the object will move even faster through your field of view as you increase the magnification. This means you are forced to take even shorter exposures¹.

With a Dobsonian telescope, recognise that 30 seconds is about the limit for exposure time before the image becomes blurred or smeared out.

Understanding the variables in a camera

Modern smartphones have pretty powerful sensors/cameras in them, and clever software that operate them. However, it still pays to understand a little about conventional photography when taking photos of the night sky.

DID YOU KNOW?

The detector, similar to the retina in the back of your eye, is sensitive to visible light. Actually, your eye is much cleverer because it has a brain behind it to process the light that it receives. However, for comparison, an iPhone 13 Pro Max's camera has 12 megapixels, and the Samsung Galaxy S22 Ultra has 108 megapixels. Your eye has about 576 megapixels.

ISO

In old-fashioned film cameras, you would have chosen your film speed by the number printed on the outside of the packet. The higher the number, the better it would perform in low-light environments.

Digital cameras have replaced that functionality with something called ISO. Again, the higher the number, the better it will perform in low-light environments. The draw-back is that if you push the ISO up too high, you end up with a black-speckled photo from electronic noise in the image. To read more detail see, 'Understanding ISO Sensitivity', NikonUSA website, <https://www.nikonusa.com/en/learn-and-explore/a/tips-and-techniques/understanding-iso-sensitivity.html>.

¹ 'Astrophotography with a Dobsonian Telescope', High Point Scientific website <https://www.highpointscientific.com/astrometry-hub/post/astro-photography-guides/astrophotography-with-a-dobsonian-telescope> (19 May 2021. (Accessed April 2023)

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Exposure time

The amount of time the shutter is open for collecting light is the exposure time or shutter speed (different names for the same thing). If you're taking a photo of someone running across your field of view and want a crisp image of that person, then you use a short exposure time (perhaps 1/500th of a second). If you're taking a photo of a flowing creek and want the water to look smooth and creamy, you might use an exposure time of a second or two.

Imagine you want to take photos of stars so that they look like pinpoints of light. To collect enough light, you will need the aperture to be open for a full 20 seconds (any longer, and the stars will become a blur as they move across the sky). Of course, this also means using a tripod or laying the camera on the ground to keep it rock steady for 20 seconds. With your smartphone, it means the telescope has to be super stable.

Make sure your smartphone camera app has adjustable exposure times. Most native camera apps have limitations for this functionality, so you may need to download something more suitable, such as AstroCam (https://play.google.com/store/apps/details?id=com.slash.astrocam&hl=en_US) or Slow Shutter Cam (<https://apps.apple.com/us/app/slow-shutter-cam/id357404131> - paid app). Remember that although you may not be able to expose as long as you like, you can take multiple shots of the same scene and add them together either in your phone's apps (e.g., DeepSkyCamera, <https://www.deepskycamera.de/en/>), or in desktop software. With a Dobsonian, 30 seconds is about as long as you can expose for before the object has rotated noticeably and becomes a blur in your photo.

White balance (WB)

The white balance is one of those settings that most of us never touch, even on a DSLR. But what is white balance? It's a setting that represents the colours more accurately. The colours our eyes see are very subjective and they have difficulty separating a pinky-white and a blueish-white, unless they're side by side. The white balance allows the software in the camera to correct for the blueish-white from fluorescent lights, or the yellowish-white from a candle.

You will want to set the WB to 3000 K to 4000 K for astrophotography.

To read more about white balance see: 'What is white balance on your camera', Digital Photo magazine, <https://www.dpmag.com/how-to/shooting/what-is-white-balance-on-your-camera/> (13 May 2021).

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F-stop

The shutter that covers the lens on your camera can open to adjust how much light reaches the detector. This 'aperture' size is referred to as the f/number, or f/stop. The smaller the number, the more light is let in. So, f/5.6 lets in lots of light; f/32 lets in very little.

Unfortunately, this variable cannot be adjusted on most smartphones. If you want this functionality you will need to use a DSLR, or download an app that adds this function.

PLANNING AHEAD

As with all things, planning will result in a higher quality outcome. If you are not that familiar with astrophotography you will need to spend some time experimenting with the telescope and smartphone camera adapter to ensure your students achieve satisfying results.

- Consider what objects you would like to photograph, and plan your viewing night accordingly. Use an app such as Stellarium (<https://stellarium.org>) to find when your object will be visible and where and when in the sky it will be visible. Also consider how bright the sky is, and whether the Moon's reflected sunlight will drown out your object. A good app such as Photopills (<https://www.photopills.com>) can help with this.
- Check the weather conditions. Be prepared to reschedule for another night or adapt if the clouds decide to descend. Most professional optical astronomers develop an instinct for the weather and don't use apps to forecast the quality of the night sky. Still, if you like apps then there are a few options listed on this webpage 'Stargazing forecast: will you have clear skies tonight?', Sky and Telescope website, <https://skyandtelescope.org/astronomy-resources/stargazing-forecast/> (7 July 2021).
- Sometimes even when the sky appears to be clear, unseen air currents can reduce the quality of the 'seeing'. This is unavoidable. Read more at 'What is astronomical seeing?', BBC Sky at Night Magazine website, <https://www.skyatnightmagazine.com/advice/what-is-astronomical-seeing/> (17 February 2020).
- Your smartphone camera app also needs to trigger and take a photo without you touching and jiggling the smartphone. Consider using the built-in voice assistant or a Bluetooth remote.

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SETTING UP YOUR EQUIPMENT

- Use these two videos to set up your telescope, finder scope and smartphone.
1. 'ASTRO 3D – How to Set Up a Dobsonian Telescope', (5:36 mins), ASTRO 3D YouTube channel, https://youtu.be/pvb-_WqNkPQ, (31 March 2020).
 2. 'Celestron NEXYZ How to | Bintel', (2:20 mins), Bintel YouTube channel, <https://youtu.be/jStDLF7eQcM>, (11 June 2021).
- Choose a location with a clear view of large portions of the sky. Ensure there is flat ground, with no tripping hazards around and with unobscured visibility into the night sky.
 - Ensure students are familiar with the process of setting up the telescope and using the Smartphone camera adapter. Having a few practice sessions prior to the viewing night is strongly recommended.
 - Set up the telescope well ahead of when you want to observe. The telescope needs to adjust to the ambient temperature outside.
 - Attach the smartphone to the camera adapter and the whole unit to the telescope before it gets too dark outside, and accurately align it through the eyepiece. Tighten it all to avoid any movement when you begin to move the telescope itself.
 - Open the smartphone camera app that you plan to use. Reduce the exposure settings. The best way to ensure the settings are right is to look at the screen and adjust up and down until you can see clearer edges around the object you are observing.
 - Try zooming in as far as you can. You may find that mid-range zoom is better for your particular smartphone's camera.
 - Using the automatic mode on your camera, take your photo.

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WHAT TO PHOTOGRAPH

There are many objects to observe in the night sky, but here are some suggestions on what to target with your Dobsonian.

With or without the telescope:

- Constellations, such as Orion, Pleiades, Southern Cross, Jewel Box.
- Star clusters (take a look at 'Star Clusters: What's the Big Deal?' (34:06 mins), ANU TV YouTube Channel, <https://youtu.be/RC3C3YdgiBw> (22 Oct 2020)).
- Huge objects such as the coal sack or the Milky Way.
- Star trails or the International Space Station.
- The Moon.

With the telescope:

- Close-ups of the Moon.
- The planets.
- Nebulae.
- Stars of magnitude within range of 7 – 13. (The dimmest star that can be seen without optical aid in a dark sky with clear conditions has a magnitude of ~ 6 , such as 29 Arietis in the constellation of Aries.)

EQUIPMENT

- Smartphone with plenty of spare memory and a fully charged battery
- Smartphone camera adapter – Celestron NexYZ
- Telescope – Dobsonian 8"
- Eyepiece – 15mm – 20mm for larger objects such as constellations, or 8mm – 12mm for planets

OPTIONAL

- Neutral density filter – useful for photographing the Moon
- Solar filter – essential for photographing the Sun

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SOFTWARE

NOTE: If you are using a computer that has been provided by your school, you may not be able to download and install all of the following software.

- Stellarium (<https://stellarium.org>) (or similar) to guide you around the night sky
- Your camera app (some devices have astrophotography, star trails or night modes)

AND/OR

- An app to control the exposure level and length of time e.g., NightCap Camera for iPhone <https://apps.apple.com/au/app/nightcap-camera/id754105884> - paid app; or ProCam X for Android <https://play.google.com/store/apps/details?id=com.intermedia.hd.camera.pro&hl=en&gl=US> - paid app

OPTIONAL

- Image-manipulating software for post-processing (e.g. GIMP, Photoshop).
- Stacking: Photoshop Express Photo Editor (<https://play.google.com/store/apps/details?id=com.adobe.psmobile&hl=en&gl=US> Requires login using Adobe ID, or Facebook, or Google [Gmail]). NOTE: This reduces the privacy).
- VStar – variable star data visualization and analysis tool <https://www.aavso.org/vstar>

(All websites accessed April 2023)