

# Getting Started in Astrophotography

By John Massey

When I first looked through a telescope at the planet Saturn I was instantly hooked on the night sky and what it held for viewing. Then it happened; the more objects I put in the eyepiece for viewing the more I found myself disappointed in the resulting view. The act of locating the objects was exciting enough but the actual views were often times less than expected. The reason is not the telescope but the limitations of the human eye itself. We can only see things in real time and our night vision is limited to the use of the rods in our eyes which are sensitive only to grays and not color.

If you are familiar with photography you know that as the light dims on a subject we have several options that allow us to take a good picture. For a DSLR (digital single-lens reflex) camera we can use a flash, change the aperture size of the lens, or change the ISO speed to improve sensitivity or lengthen exposure time. Of these options the best by far for astrophotography is to increase exposure times as objects in space are very faint, distant, and we are already at maximum aperture. When we increase the exposure length of an earthbound object we better hold the camera steady or the resulting image will be of extremely poor quality. Using a tripod to mount the camera will improve this but every time we touch the camera to release the shutter we can cause vibration that again affects the quality of the image. Adding a remote shutter release resolves this issue. These same problems exist if we want to take images of the night sky with one exception, we have to also compensate for the Earth's rotation as we image or we end up with trailing in the final image and the target will eventually move out of the FOV (field of view). Hence no detail can be resolved.

This article is intended to assist in the equipment decision-making process for those who wish to partake in astrophotography and therefore addresses the issues previously discussed. Image processing techniques are not presented here, as it is a topic that requires a great deal of study and practice for the user's specific image processing software. Solar imaging requirements will also not be discussed here.

## WHAT SHOULD I IMAGE?

Identifying the type of target you want to image will enable you to put some constraints on your initial investment in the gear you purchase. It would be great if we could image everything but if you are like me some restrictions must be in place as you have other priorities in life. Make no mistake, this hobby can get expensive. The type of target you want to image will help in deciding what telescope you will need. There are generally two types, DSO's (deep sky objects) and planetary or solar system. The DSO's are distant and faint and run the gamut of very large, e.g. NGC7000, the North American Nebula or M31, the Andromeda Galaxy, down to very small, e.g. M57 the Ring Nebula in Lyra. The planets are very bright but very small objects that require higher magnification or focal length telescopes to resolve detail. Wanting to image both target types and sizes can impact the initial budget significantly. I personally chose to image the larger DSO's. With the target type decision made it is time to move on to the type of telescope.

## SIZE MATTERS

Different telescopes weigh different amounts and it is the weight of the entire payload (telescope, camera, filter wheel, field flatteners, etc.) placed on a telescope mount that will determine the carrying capacity of the particular telescope mount one should purchase. By "mount" I mean the motorized head

to which you attach the telescope without the tripod or pier. A general rule to follow is the payload should be about half the mount capacity. This is not a rule that is cast in stone however as I have imaged successfully at 75% of mount capacity. Refractors are better suited for large targets and Schmidt-Cassegrains for smaller targets such as planets and planetary nebula. Their weights vary by size.

The type of telescope you select will dictate how quickly the vibration settles down after positioning of the mount due to guiding corrections. My recommendation is don't try to precisely match the payload to the mount, leave some wiggle room and overdo the mount capacity as this will give you the provision for upgrading later on. Be careful when looking at telescopes matched to mount combinations that say they are good for imaging, especially Schmidt-Cassegrains with fork mounts. Yes, you can image with them but unless a wedge is added you will experience field rotation in your images. Imaging packages using the GEM German Equatorial Mounts, in my opinion, are a better option; be careful as not all GEM mounts are the same. The mount is the workhorse of your system and is where you should spend the most time researching the quality vs price. There is no free lunch when the mount is concerned. Whether you buy a fork mount or GEM make certain that it has a computerized go-to controller that allows autoguide (ST4) and computer interface either serial or USB.

## TRIPOD VS PIER

Imaging packages usually provide motorized mounts on a portable tripod allowing for field work. You can take them to a dark sky site and image away, provided you have a power source to run your equipment. Deep cycle marine batteries usually do the trick. Keep in mind that set up and alignment are required every time you move to a new location and that the equipment is heavy. The other option is to have a more permanent arrangement using a pier. A pier reduces set up time because once in place it is always level and preset for polar alignment with your mount.

## YOU WILL NEED A CAMERA!

Now that we have the mount, mount base (tripod or pier) and telescope selected we need to decide on a camera. This decision again is driven by the type of target you want to image. Any CCD (Charge-Coupled Device), CMOS (Complementary Metal-Oxide Semiconductor), or DSLR camera that will allow you take long exposures is a good selection for the DSO's. If you plan on taking images of planets you must buy a camera that will allow you to shoot video. There are several manufacturers of these cameras. Browse the internet and find your options. DSLR's can be purchased already configured for astro-imaging. Those that are not will have to have the IR cutoff filter removed from the front of the chip. That filter is in place so that we can take more natural color images of landscapes and portraits. Don't worry too much about losing the normal functionality of the DSLR, you can add an IR filter to the front of your camera lens and be back to normal imaging again. This modification will increase the chip sensitivity to red. Hydrogen Alpha is the predominant gas in many nebula and emits light at a wavelength of 656 nm, which is just at the edge of bandwidth for the IR cutoff filter. This means that this important astronomical wavelength will be attenuated strongly by the IR cut filter, hence the requirement for the modification to DSLR. CCD and CMOS astrocameras do not have IR filters built in so they are already sensitive to all color wavelengths.

CCD and CMOS astrocameras are available in two configurations and offer chip cooling to reduce noise. One type of camera is OSC (one shot color). These image only RGB selected colors and have a Bayer matrix filter array built on their chip. The filter array is a set of four pixels: one Red, one Blue

and two Green. This grid is repeated over the entire chip surface. The advantages of these types of cameras are when taking one frame you get a full color image after the Bayer matrix is interpreted by software and this can keep imaging session times to a minimum. The disadvantages of OSC cameras are they are not as sensitive as a monochrome CCD or CMOS camera. When starting out in astro-imaging these, in my opinion, are the better CCD type camera to start imaging with. Less imaging time is required and image processing techniques involved are much simpler than those for monochrome camera.<sup>1</sup> The following is an image of M20 the Trifid Nebula in Sagittarius taken with an Atik3141 OSC camera.



The monochrome or mono type CCD or CMOS cameras are the type of cameras used by professional astronomers. The chips in these cameras do not have a filter array built in as the OSC cameras do. This means that all the pixels on a chip are used for only the color or filter wavelength as determined by the imager. This is significant for scientific studies of objects. This type of camera requires a filter wheel that contains user specific filters typically R, G, B, and Luminance or clear and maybe some NB (narrow band) filters such as H $\alpha$ , OIII and SII. The Hubble Telescope uses this type of camera for its imaging, just a lot more expensive than the usual amateur CCD. Because all of the pixels are used for all color wavelengths, sensitivity is increase by a factor of four compared to an OSC camera. This sensitivity comes at a cost; each filter used in an imaging session must be taken separately and combined later to produce a color image. That is to say: if an OSC session takes an hour to produce the final image a mono session imaging through the Red then the Green and then the Blue filter would take three hours to produce the same image but of higher quality. This can be problematic to the amateur who doesn't have an abundance of time to image or is not able to finish an image because of weather conditions for successive nights of imaging. Additionally, for each filter change focus must be checked and corrected. This type of camera is not for the faint of heart but produces excellent results if processed correctly.

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<sup>1</sup> Of course, all DSLR cameras are of the OSC type.

The following image was taken with the Atik 383 monochrome camera. The image is a false color representation of SH2-155 Cave Nebula in Cepheus. Imaging was done through H $\alpha$ , OIII and SII filters. The SHO or Hubble color palette was used during processing.



There are differences between the CCD and CMOS cameras which I won't go into in depth. The CMOS cameras have additional settings of gain and offset. These affect camera sensitivity and noise by limiting the full well-depth (i.e., the ability to contain photoelectrons) of each pixel and requires some experimentation by the camera user to determine the best settings for their personal imaging set up. CCDs do not have these settings. Both cameras produce high quality final results after processing.

## TIME EXPOSURES AND AUTO GUIDING

If you have ever seen a really nice image of a deep space object be aware that a great deal of work went into producing it. Because deep space targets are so faint, the only way to capture enough photons is to take long exposures. I routinely take 5, 10 and 15 min exposures, but others may take 20 and 30 min exposures. These long exposures are only possible because we use an additional camera as an autoguider. The autoguider camera is attached to a separate telescope or an off axis guider device that is placed in the optical path of the imaging telescope. A small prism in this device captures a star near the edge of the imaging scopes FOV and reflects it up a tube to the guide camera. It must be noted here that prior to guide cameras an illuminated reticle eyepiece was used in these devices and the imager would patiently observe any star drift and then manually compensate his mount to keep the star on the target crosshairs of the reticle. To give you an idea of how much easier imaging has become for today's amateur please reference Dick Suiter's article in the club website entitled [The New Astrophotography](#). It must have been literally a pain in the neck to guide in those days. Fortunately, the autoguiders of today have made it very easy. Auto guiding packages are available on the Internet and most if not all use the free software provided by Stark Labs PHD2 available here, at [openphdguiding.org](#).

## NOW WHAT?

By now you may be asking: how does this all work together? Well it requires a computer either PC or Mac. All the cameras will require their drivers to be installed on the computer and USB cable connections for communication. Additionally software will have to be installed that actually controls the cameras coolers, exposure rates, any filter wheels, etc. I won't go into depth as to how it is all set up because each piece of hardware is different but suffice it to say that your computer will control the imaging session's equipment and store all the image files that you take during your session for further processing.

Image processing is where the real magic begins. You have to start with good data, but incorrect processing will not give you good results. Processing is where you will spend most of your time learning and there are volumes of tutorials available for all processing software.<sup>2</sup> Some of the processing software is free but in my opinion the better software is purchased. It doesn't matter what you use, what matters is that you enjoy yourself and are proud of your resulting images.

## CONCLUSION

To me personally the hobby is extremely rewarding. I have always enjoyed looking at the night sky and photography so it was only natural to combine the two. What has always fascinated me is that when I look at a spot in the night sky with the naked eye I wouldn't see very much, but the camera brings that area to life with amazing color and detail.

Before you pursue astronomical imaging though be aware that it can get expensive just like any other hobby. Make your decisions cautiously and with future possibilities in mind to avoid accumulating used equipment. It's a bit like the "I wish I bought a bigger boat" syndrome.

Be very patient: Astro imaging is hard to learn. If it wasn't, everybody would do it. Many things can frustrate you in the process of learning and enjoying it, such as ...

*Equipment failure:* with all the USB cables and power cables, things can work their way loose.

*Weather:* All the planning in the world can't make the clouds go away and not many weather men are all that accurate at cloud predictions. But set up anyway, if there is a chance you might have a clear patch of sky you will be ready and it doesn't hurt to practice polar and drift alignment

*Full Moon Curse:* Once into the hobby you will begin to realize all the good clear nights are during the times when there's a full Moon, at least it will seem that way.

*Local light pollution:* Close city streetlights and the neighbor's security lights cause gradients on your images that have to be removed during processing. You will find this to be a minor issue as processing can remove it and light pollution filters are available to help minimize it.

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<sup>2</sup> [ed. note: Some of the theory behind the processing steps can be learned in the book by Richard Berry and James Burnell, *The Handbook of Astronomical Image Processing*, Willmann-Bell, Inc. 2000-2005.]

Image processing is complex: Many a time I sat down at my computer to process an image that had a specific problem I needed to resolve but had no idea how. I found that manuals were okay for teaching how a process works but getting it to work in my case meant a great deal of trial and error with settings. If you are the type that expects instant gratification this may not be the hobby for you.

I found that some of my best resources for help were internet forums where other imagers resided who were using the same processing software. Join a forum, post your images and request comments and criticisms, but keep a thick skin because you know how much work you put into a final image and may take criticisms personally. Other imagers can point out some issues with your image that may need correcting or improving and even offer ways to correct them.

I hope this article has been informative to those who may be considering getting into the hobby of astrophotography or astro-imaging as it is sometimes called. One final thought, to me astro-imaging has not been so much about the destination but about the journey.

Clear Skies to All

[Ed. note: for more John Massey images, see <https://www.astrobin.com/users/jmfloater/>  
This website seems to hang with some browsers. If it does not appear to be loading properly, push the little "reload" icon and it wakes up.]