

Astrophotography Beginners Information

Introduction

A. What is that bright object in the sky.

1. I started out with wanting to know what that bright object in the sky is that I could see in my backyard with the city lights all around me. Oh, it was not the Moon. I decided to get my target spotting scope. So, with my 20-60-power x 60mm spotting scope and a bit of time, I located the object. To my surprise it was Saturn.
2. Now if I can see the disk around Saturn what can I see with a real telescope.

B. First telescope & camera setup.

1. That Christmas I purchased a Meade DS114 TeleStar GoTo scope for about \$350.
2. Meade DS114 TeleStar GoTo scope is a 4 1/2" mirror Newtonian type telescope and it came with a computer handset. The eyepieces were small, and I changed them out to the standard 1.25" eyepieces. I also got a 2" eyepiece and its adapter to change out on the telescope's focuser. I also put on an electric focuser that worked with my handset control buttons.
3. Why choose a GoTo scope? I got this type of scope because it tracks automatically after you align the scope through several procedures. However, this type of scope is not polar aligned which is needed for longer than 15-sec exposures. The scope also, after a successful alignment, find objects on its own without you having to read a star map and star hop to the object you wish to see. The handset has night tours and other features to find objects in the sky.
4. My first picture was of the Moon using a Nikon N70 film camera. I was not successful with deep space objects since the exposure for such objects takes more than 15-seconds for film. For the camera I got adapters; a T-ring and a 2" nose piece to fit into the telescope's focuser. You focused the picture using the telescope's focuser knob. Due to the camera's focal plate being a matt finish it is hard to get focus on dim objects that are not bright planets.

C. Researching for taking better astrophotography pictures.

1. The internet has many sites for all types and styles of taking pictures of the night sky. There is information for taking pictures from a telescope, on top of a telescope and from stationary tripods. There is also, night sky landscape picture taking and time lapse.
2. After some research I decided that if I stay with film I needed a camera that I could focus better on my night sky objects. So, I purchased a used Nikon F3 camera and purchased a replacement for the focal plate it came with. Nikon F3 cameras do allow changing out their focal plate. So, I got a focal plate with a clear circular dot that was in the center of the focal plate surrounded by a matt finish. Still did not get that great of shots with film and again shots of dim objects needed longer exposures. Also, there is the expense of development of the film and only getting a few if not any decent photographs.
3. Digital cameras to the rescue. By this time in my hobby, digital cameras were coming to the market place at prices that were affordable to me. I purchased a Nikon Coolpix 4300 camera and two adapters. The adapters allowed me to attach the camera to the telescope's eyepiece. Thus, allowing eyepiece projection for pictures. I focused the space object in the eyepiece attached the camera to the eyepiece and the camera focused on the object in the

eyepiece. Now I could take many shots of the same object and stack the photos in stacking software. However, still a 15-second exposure limit.

- D. Helpful web sites; I use several for additional knowledge. Lots of info on YouTube
1. Astrophotography Tutorials - Dough Hubble; <https://www.youtube.com/user/DugDog>,
 2. Craig Stark - <http://www.stark-labs.com/craig/index.html>, You will have to search YouTube for his videos
 3. David Rankin – Rankinstudio; https://www.youtube.com/results?search_query=Rankinstudio
 4. Dough Hubble on What Equipment Do You Need For Astrophotography? <https://www.youtube.com/watch?v=GZjy3ed59Mw>
 5. Forrest Tanaka; https://www.youtube.com/channel/UCx_N3KiUvb4M2-NyKRugXmw and he has one video of the Andromeda Galaxy not using a star tracker; <https://www.youtube.com/watch?v=e0JSTF8SGi4>

Getting serious with Astrophotography

- A. After much research I decided I needed a newer telescope that would allow polar alignment and also be a GoTo scope. However, I learned later that I did not know all the particulars regarding the type of scope needed and their ratings for faster and more light reception.
- B. New telescope with both polar and alt-az mounting features, I purchased a 10-inch Meade LX200GPS fork mounted telescope. This is an expensive scope as most are if you want to get serious. If I had it all to do over again, I would have gotten a German Equatorial mount and with a telescope with a wider field of view and reduced f-ratio ($f/\text{ratio} = \text{focal length} / \text{aperture}$). I am still trying to understand f-ratios and have to refer to the internet for information that might help me. However, the telescope I have is excellent for deep space observing in addition to taking astrophotography. Many other people who take astrophotography have the same type of Meade telescope I have, while some are smaller and some are larger.
1. Aperture, f-ratios, myths, etc; <http://www.stark-labs.com/help/blog/files/FratioAperture.php>
 2. CCD “f-ratio” Myth; http://www.stanmooreastro.com/f_ratio_myth.htm
- C. New cameras; I decided I needed a new DSLR with more features for both my Astrophotography hobby and family pictures. I got a Nikon D70 mainly because, my Nikon SLR camera lenses I already had for my N70, are interchangeable with my new Nikon D70-DSLR. I realize now that I should have gotten a Canon DSLR. However, years later proved to be beneficial, that I just needed to wait for Canon to make a camera for both Astrophotography and everyday use. Technology changes so fast now, that cameras are out of date after a few months or years. But that does not mean you cannot get great photos with Nikon, Canon or other camera brands just because they may be antiquated.
1. D70 modifications; I even changed out my focal plate to a lesser matt finish as suggested by some other Nikon users doing astrophotography. However, in my view the change did not aid me in the ability to achieve a good focus viewing through the camera. I still had to download the pictures and view what was shot only to find that I was out of focus. A waste of time since the camera does not do live view.
 2. Deep space CCD cameras; Meade DSI cameras just fit into the eyepiece holder and come with software that allows you to take pictures and automatically stack the pictures. You do have the options to save all pictures and stack later or save only the combined pictures. I have two of these one does both color or black/white and another is only black/white but does have RGB filters. Using the RGB filters you can take photos with each filter and stack them later for a colored photo. Many times, I have had to use a focal reducer, in front of the

- camera, to get the whole object in the picture frame. You are photographing the image on the telescope's mirror and it can be quite large if not viewed through an eyepiece or focal reducer. I have at times used both the focal reducer and eyepiece with my Coolpix 4300 camera to get the object in the picture frame using eyepiece projection.
3. Canon EOS 60Da; This camera is specifically design for both Astrophotography and daytime use. With the camera's live view and a computer, the telescope, or if the camera is using a lens other than the telescope, you can achieve focus viewing the computer screen. However, you will have to use the focus knob on the telescope or focus the camera lens manually. Autofocus does not work well on space objects due to the dim light conditions. There are aids to acquire focus such as Bahtinov Mask which can be acquired for both telescopes and some camera lenses. Most all the time I use the focal reducer with the Canon EOS 60Da.
 4. Filters; You will need to research the type of filters you may want to use. Some attached to the lens of a camera and others can clip inside the camera's sensor. Helpful web links;
https://www.youtube.com/watch?v=s34_XfDfgOA &
https://www.youtube.com/watch?v=w5_7Zi6f30&t=12s
- D.** Guiding; If you use a telescope, that can be polar aligned, you will need one that allows for the added feature of a guide scope.
1. I use a guiding software called; PHD which stands for Push Here Dummy. The guide scope requires a guiding camera that has a wired connection to the telescope's guiding port and to a computer. It is free; <http://www.stark-labs.com/phdguiding.html>
 2. There is software for achieving polar alignment now without using the additional polar alignment scope. One is called Sharpcap but you will need the Pro version for polar alignment plate solving. It is free, but the Pro version is a yearly fee in Euro. This year the fee was \$15. <https://www.sharpcap.co.uk/sharpcap/features/polar-alignment>
- E.** Advanced cameras; There are many advanced cameras for deep space photography as well as filters to pop out the nebula gases. Of course, many people will use an IR filter especially in the light polluted areas. However, there are light pollution filters that may be a bit better even for out in dark sky places.
1. Advanced CCD cameras for deep space; there are many types of these cameras and they can get quite expensive. I have one that takes video which was design exclusively for planets. They can be purchased either as color cameras or mono. Lots of astrophotography hobbyist tend to use the mono with RGB or more filters. I have not tried to take deep space with my ZWO CCD camera, but I have seen others that have done it. Most of my Deep Space shots have been with my Meade DSI CCD cameras if not with one of my DSLR's.
 2. Some popular CCD cameras today are the ZWO line as well as others. You just have to search on the web and forums to see what camera will suit your needs and pocket book.
 - a. <https://agenaastro.com/zwo-astronomy-cameras-buyers-guide.html>
 - b. <https://astronomy-imaging-camera.com/zwo-all-products/>
- F.** Attachments I found did not work well.
1. There is an attachment that is supposed to work with both SLR and DSLR cameras that allows you to put an eyepiece in the item and then attached the item to the camera using a T-ring. I have tried it and I have two types. I have not been able to get any good pictures using the item. Others have, but I have not, especially with digital cameras. I get a good focus on the center of the object but stars toward the outside of the center are not in focus using a DSLR. Do not even bother with an item such as the Meade Variable Projection Camera Adapter or the Meade Basic Camera Adapter or similar products that allow an eyepiece to be

- put inside of them. I get better eyepiece projection pictures using my Nikon Coolpix 4300 attached to the eyepiece. I do not understand why it works in the Coolpix and not the advanced DSLR.
2. Telescope Manual focus; If the eyepiece receptor or mirror focus knob is not a finally engineered smooth moving manual knob you may want to have an electronic focuser that has fine, medium and fast speeds. Manual moving the focus knob that is not a precision type can be frustrating in trying to achieve fine focus.
- G.** Tripod guiding; there is equipment now that allows a camera, with an attached camera lens, to be mounted to a tripod and will guide across the sky. I do not have one, but one member of our club does use one. There are several manufactures who make these types of tracking mounts. Most have to be polar aligned and probably have a weight limit. With the many different types of camera lenses, you can get some very good wide-angle views of the night sky. However, for really close up deep space objects; you will need a powerful camera zoom lens or a telescope. German Equatorial mounts can double for just using a camera in lieu of the telescope. But remember that you can mount the camera on top of most telescopes with the proper attachments.
1. Vixen Optics Star Tracker; their web site has some links to YouTube videos using their equipment. <https://www.vixenoptics.com/Vixen-Polarie-Star-Tracker-p/35505.htm>
 2. iOptron Sky Tracker; <http://www.ioptron.com/category-s/111.htm>
 3. Build your own star tracker; <http://www.instructables.com/id/Build-a-star-tracker-for-your-DSLR-and-make-your-o/>
 4. There are some others you just have to research online.
- H.** Power needs; you would not want to run out of battery power in the middle of taking long exposures especially in a long series of long exposures. While a camera battery may be fully charged it may not last the night. You do not want to change out batteries in the middle of a photo session which could get your setup out of alignment especially if you are tracking.
1. You need to have power for the telescope or tracking device to which the camera is attached to. Most telescopes run off a 12V power sources and have an AC/DC accessory (wall wart) that you can purchase separately. However, some telescopes power leads may have the cigarette plug for the battery connection at one end and the round jack at the other end that plugs into the telescope's power input plug.
 2. A deep cycle marine battery or similar portable power sources are available. Most portable power sources have two cigarette plugs. For a car/marine battery you can get a power converter that connects to the battery post and has several outlet plugs. I would get one with no less than two or four outlets. With just two plugs I use a pigtail outlet in each outlet that I can connect a 3-plug outlet to thus giving me 6-plug-ins total.
 - a. Power tank; <http://www.giantfreakinrobot.com/reviews/portable-power-telescopes.html>
 - b. Power converter; <http://www.batterychargers.com/xi75du/>
 3. You need power to the camera. Best is to have the AC/DC power converters recommended by your camera manufacturer. This device can be plugged into an outlet that supplies power. The device is most likely **not** your accessory that charges the battery.
 4. You need power to combat dew. There are 12-V heat guns and there are dew heater strips. The heat gun is used when your lenses start to dew up and you will use it many times during the night when dew or frost is present. However, I prefer dew heater strips. They come in different lengths and with a controller to control the amount of heat that also uses the outdoor temp to regulate power usage to the strips. There are several manufacturers of dew control devices. I use a DewBuster controller (<http://www.dewbuster.com>). The DewBuster web site has additional information about making your own items to control dew. For the heater strips

- I use Dew-Not (<https://www.dew-not.com/dew-not-desc-01.htm>). The strips can be acquired for both telescopes, eyepieces as well as camera lenses. You will need to measure the circumference of the item you wish to wrap around with a dew heater strip.
5. You need power to your computer. While on computers; it is good to have one with a backlite keyboard. The backlight should be red, and you need a software program or a red film/plastic sheet to make your computer screen a red tint. Star parties prefer red light so your night vision is not hindered.

Camera lenses and software

- A. Camera lenses selection is vast. I suggest doing research on the internet. Low f-stop is ideal, and the camera's ISO should not be set more than 1600. Higher ISO will show noise. Caution; I have found that some teleconverters may not work with some lenses. You need to check with the manufacturer regarding using teleconverters.
 1. ASTROPHOTOGRAPHY 101: How to choose the best lenses for astrophotography? TUTORIAL - 4K; <https://www.youtube.com/watch?v=lgmUpfel6bU>
 2. Astrophotography 101 - Lens Guide and Recommendation; <https://www.youtube.com/watch?v=vL14iQNm4U>
 3. Rokinon 14mm- Best Budget Lens for stars?; <https://www.youtube.com/watch?v=TSrFKLzsrQ>
- B. Software; there are numerous software programs out there. Some are free and some are not.
 1. I use DeepSkyStacker for stacking my deep space shots most of the time.
 - a. Web link; <http://deepskystacker.free.fr/english/index.html>
 2. RegiStax6 for stacking most of my videos for planets. RegiStax6 actually imports the video file and breaks out the individual frames. At times I have used RegiStax6 for some deep space shots.
 - a. Web link: <http://www.astronomie.be/registax/download.html>
 3. I also have Nebulosity which allows taking pictures, viewing and stacking your pictures. It is not a free software.
 - a. Web link; <http://www.stark-labs.com/nebulosity.html>
 4. I use my camera's computer software for camera control from the computer.
 5. Free software; While sites offer free software, please remember that some of the program writers, do this work on their own time and a **DONATION** is a good way to say **THANK YOU**. Just be sure you are getting the software from a reputable site.
- C. Stacking procedures and terms
 1. Lights; these are your actual pictures. You will take many more lights than any other pictures used in the stacking procedure.
 2. Darks; these are pictures using the same shutter speed and ISO settings as you used in the Lights. However, these are to be taken with a cap over your lens. The number of Darks you take should be at least $\frac{1}{4}$ of the Light count you took or no less than 5. (ex: if you take 50-Lights you should have no less than 5-Darks or a bit more. The Darks help take out the Noise in your Lights when stacked. Forrest Tanaka took 400-Lights @ 1.6-seconds for each shot and only 20-Darks and 20-Bias in his YouTube video on the of the Andromeda Galaxy not using a star tracker; <https://www.youtube.com/watch?v=e0JSTF8SGi4>
 3. Bias; These are pictures using the same ISO settings as your Lights but with the shutter speed set to the fastest shutter speed your camera will take. You will take these pictures also with a cap over your lens.

4. Flats; I do not take these, but some say it also helps. Flats are pictures taken with a T-shirt over your lens to aid in removal of dust particles that might be on the lens.
 - a. How to Take T-Shirt Flats - Astrophotography Tutorial
<https://www.youtube.com/watch?v=aHi4ddBjwNY>
 - b. How to take Flat Frames for Astrophotography
<https://www.youtube.com/watch?v=g3zDn-8s-k>
5. Offset/Bias files; I do not take these, but they are listed in the DeepSkyStacker program. I am sure there is information on these on the web.
6. You would import the above pictures into your stacking software program. There are many YouTube videos on using the various picture stacking programs.
7. It is recommended that after taking your Lights you should take the Darks and others, so you will have the same camera temperature and night temperature. I do not always do this.

Picture procession – Landscape – Tethering

A. Programs to use;

1. There are a lot of programs to process astrophotography pictures. I use Adobe Photoshop CS2. It is an older program but not many people can afford, as a hobby, the newer programs with what Adobe has done to the pricing of their software with the monthly fees.
2. Add-on features; There are some add-on features that can be purchased for use in Photoshop that are specifically for astrophotography. I have one but there are some others that I would like to have as well. The one I have is an Action feature called, Astronomy Tools v1_6. Web link; http://www.prodigitalsoftware.com/Astronomy_Tools.html
3. Many YouTube tutorials I have viewed show people using Lightroom and other versions of Adobe Photoshop. However, most of the time I am searching for Photoshop tutorials and not other picture processing software. I am sure with some web searching you can find other programs to process you stacked pictures.

B. Night landscape with star filled sky

1. Stacked still images using a stationary camera tripod provide very good images of the landscape foreground; however, longer exposures or a series of shorter exposures will result in star streaking. Still shots of the sky without using a zoom lens could be done with no more than 15-second exposures. If a zoom is used the time of the exposure is even less.
 - a. Some landscape astro-photographers track the sky to get pictures to avoid star streaking. They also take photos of the landscape without tracking. With editing software, they are able to mask and layer photos to get a stacked landscape imported over the stacked star picture. Resulting in sharp stars over a sharp landscape.
 - b. Others do a similar method but use one of the landscape pictures from the tracking as the foreground.
2. Time-lapse; this method is basically making a movie from single pictures of the stars movement in the sky. It can be done with a stationary tripod and the camera never moving. You can just shoot the sky or have some landscape in the picture. Here again to avoid star streaking exposure time cannot be too long.
3. There is much more information on the web regarding landscape and time-lapse photography. I have only done a time lapse of a meteor shower using a stationary tripod and camera.

C. Tether cameras

1. With many of today's DSLR's you can connect the camera to a computer and have most all the controls of the camera controlled from the computer. Some of the older cameras you can tether but may not have a live view of the picture on the computer. Others you can just program the camera on the number of shots to be taken and have no control from the computer as to the camera's shutter speed.
2. The most important method of taking astrophotography with any camera is to have a remote shutter release to avoid camera vibrations resulting from one pressing down on the shutter button. Even a mirror flop during a photo session could cause camera vibration. However, wind could cause the camera to move during any exposure time. Wind is not my friend if it is over 2-mph with my large telescope. Even 2-mph maybe an issue with a light weight tripod camera mount system.
3. Cameras, when mounted onto a telescope and under a tether control, will need to be checked upon during a long photo session. You need to make sure your camera does not interfere with the telescope mount during the telescope's tracking and or if there is to be a meridian flip during the photo session. Meridian flip occurs on a German Equatorial type mount but not on a fork mounted telescope.
 - a. Meridian flip web links to show the flip; <https://www.youtube.com/watch?v=-9q3Ft8TCoU>, <https://www.youtube.com/watch?v=1njecdYbsec>, <https://www.youtube.com/watch?v=AC5YO1BTYqY>, <https://www.youtube.com/watch?v=mH0WwTpNGGU>,
 - b. My telescope is a fork mounted type and use a wedge for polar alignment. Here is a web link showing that the Meridian flip does not occur; <https://www.youtube.com/watch?v=-9q3Ft8TCoU>
 - c. Telescope and attached equipment balancing is important, you do not want to damage your telescope and your camera attached to the telescope; web link for a German Equatorial Mount; <https://www.youtube.com/watch?v=V3cWcj4Fb1A>

Conclusion

- A. Determine and research the method and type of taking astrophotography you wish to do.
- B. Determine and research the equipment and software needed for your type of astrophotography.
- C. Astrophotography is said to be the hardest type of photography and it takes many hours and pictures for just one picture.
- D. A final mention; Acquire a red-light flash light for night photography so you can walk around. Most star parties require the use of a red light during the observing session. White light is only allowed after the session ends for all. Do not forget about red screen for your computer or some way to shield the computer's light from others.

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