Photographing the Milky Way without Special Equipment

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Rev 08-24-2016

The Milky Way is a dramatic feature of the night sky, but it is very dim. It consists of interstellar dust and the one hundred billion stars that comprise our galaxy. The galaxy's shape is somewhat like two dinner saucers stacked face to face, but with the stars arranged in spiral arms radiating from the center. We are partway out one arm so we see much more structure as we look toward the center of the galaxy than as we look away. In the northern hemisphere that interesting galactic core region is near the horizon, less so as you move toward the equator. In the mid latitudes of the southern hemisphere the galactic center region is almost directly overhead.

In order to see the Milky Way well you need a very dark location with clear air, well away from city lights with an unobstructed horizon and minimal light pollution to the south and southwest. And you'll want the last few days before a new moon or the first day or two after. In the northern hemisphere it will be an arc across the sky from about April through September, running more or less north to south and moving farther west each month. In the southern hemisphere it will be most visible in their summer. There are a number of smartphone apps and computer programs for locating it.

Our eyes don't see color when light levels are low, but the camera does, so a photograph can show some subtle colors. The truest rendition will be obtained by setting the white balance to the Daylight setting. Light pollution will result in an overall warmer tone as tungsten and sodium vapor light is scattered by tiny particles in the air. You can compensate for it somewhat with the White Balance setting in a raw converter but it can be corrected more accurately with the individual color channels of Curves in Photoshop (detailed below).

You'll want a fairly wide-angle lens. I like the composition I get with 24mm on a full-frame body or about 14-17mm on an APS-C crop body. But many wide-angle lenses give stars that are streaked out toward the corners and many will render stars with strange shapes and colored halos, worse in the corners. In some cases you can reduce these artifacts by stopping down, but there is a limit to how much light you can afford to give up.

Because the features are so dim you'll need a high ISO, a large aperture and a long exposure. Newer and higher end cameras will give better results because of the lower noise at high ISOs. Generally you will want something in the range of 3200 to 6400 for a 15 second exposure at f/2.8. You'll need to set the camera to Manual mode so you can set the ISO, shutter speed and aperture.

You'll have less noise if you use an ISO that gives a good exposure rather than increasing exposure afterwards when you process the files. (This may be less true with some of the

newer very high end Nikon and Sony bodies.) And shooting raw files will give a better result than JPEGs if you have a good raw processor.

The earth's rotation causes stars to move in the field of view during the exposure time. The longer your focal length the more movement the stars will make across the sensor during the same time. For 24mm on a full frame sensor, an exposure of 15 seconds will cause the stars to be elongated by about two times.

You'll need a tripod, the sturdier the better. And you'll need to use either a remote release or your ten-second self-timer to avoid camera shake when you trigger the shutter. If your camera has it, using Live View will prevent shake from the mirror slapping up. For others that have a "silent shutter" mode, it may be enough. Checking your shots magnified on the LCD screen should let you decide.

You'll need to use manual focus. Accurate focus is important for image quality. An out of focus star is not pleasingly fuzzy, it is an unattractive circular blob. And you can't count on just setting the focus ring to the infinity mark. If you have Live View, zoom in on a star and move the focus ring till you get the smallest star. Otherwise, start at the infinity mark and shoot a test exposure and then zoom in and check the focus on the LCD screen. Bear in mind that the highly magnified on-the-fly JPEG you see there will not be as sharp as your final raw file. Strong reading glasses will help with either strategy but I prefer a Hoodman loupe, which is also great for shooting video. Once I have good focus I tape the focus ring (very carefully!) so I don't inadvertently move it.

If you want to include a foreground object, you may have to choose between sharpness on either it or the stars. A useful strategy would be to find the best focus for the foreground before dark, when you can use autofocus. Tape the manual focus ring before you autofocus and then switch to manual focus. Then when it's dark enough to see the Milky Way you might be able to reposition the camera for the best composition without changing the distance to the foreground significantly. Make the image, then zoom in and check focus for the stars and re-focus on them and re-shoot if necessary. You can composite the two images in Photoshop.

If the foreground has no movement you can try a longer exposure and lower ISO, which may give less noise. Or you can shoot several exposures and stack them to remove some noise, as described below. You can get a very nice effect if you shoot the foreground before it is fully dark, or with some moonlight or light painting.

Noise will be a major issue for the long exposures and relatively dark subjects in night photography. You can reduce it somewhat in the raw converter, and then you can do more in Photoshop with noise reduction techniques and software (see below). But significant noise reduction comes at the expense of detail.

Many cameras have a setting for Long Exposure Noise Reduction. It will cause the camera to take a second "dark" exposure (shutter closed) of the same duration as the main exposure, but it only removes the tiny colored dots of hot pixels, very tiny light

specs and red smudging near some edges called by amp glow. It does not remove the usual "grain" noise we deal with in daylight photography, which is random from one exposure to the next. All these types of noise are less of a factor at shorter exposure times and lower ISOs.

The only way to know if Long Exposure Noise Reduction will help your files is to try it, under the conditions of your night photography, using the same ISO and exposure times. You will probably need to inspect the files on the computer at 100% or more to see any effect, but the cleaner the files the better your finished results, even if you aspire to no more than a JPEG for the web. If you are not doing a series of exposures that need to be done in quick succession to minimize star movement in between, and can spare the extra time, it is a good idea to do it.

Otherwise you can get a similar result (although not quite as good) by taking a dark frame at the same ISO and temperature immediately afterwards (so the sensor is also at the same temperature) with the lens tightly covered so no light reaches the sensor, and subtract it in Photoshop by stacking it above the main exposure and setting that layer to Difference or Subtract made. If you process Canon raw files with Adobe Camera Raw or Lightroom, hot pixels will be removed automatically – see below. Amp glow is much less of a factor with newer cameras.

If your camera has a setting for High ISO Noise Reduction, read the fine print. For Canons it only applies if you shoot JPEGs.

Processing exposures in the raw converter:

Bring the files into the raw converter and adjust tonalities to taste. In addition to hot pixels, Adobe Camera Raw and Lightroom will automatically remove color noise but at high ISO and long exposures, you may need to remove a bit more with the Color Noise Reduction slider in the Detail panel. Don't increase saturation or contrast, as you can increase them later in Photoshop but you generally can't get a good result trying to reduce them once they are overdone in raw conversion. Be careful with noise reduction so you don't sacrifice too much detail. If you have a yellow or orange cast due to light pollution from city lights, don't use the White Balance slider to correct it. It should be done in Photoshop with Curves (see below).

Processing several exposures in Photoshop to remove noise:

It is possible to average the "grain" noise in several exposures, as it is random between exposures. But it will take a number of shots to have a significant effect. Noise will be reduced by the square root of the number of frames, so 25 frames will reduce noise to

one fifth. Make several shots in quick succession (to minimize star movement between frames) and optimize them identically in the raw converter as above.
If you are using Lightroom you can do this by selecting one and adjusting it and then select the others (keeping the adjusted one "most selected") and click Sync to assign the others with the same adjustments. (You can do the equivalent in Adobe Camera Raw or other raw converters.)
In Lightroom, go to Photo > Edit in > Open as Layers in Photoshop.
(You can do the equivalent in Adobe Camera Raw or other raw converters, or open and stack them manually.)
In Photoshop:
Select all the layers (click on the top one and shift-click on the bottom one)
Edit > Auto-Align Layers (choose the Auto method)
Layer > Smart Objects > Convert to Smart Object
Layer > Smart Objects > Stack Mode > Median
Layer > Smart Objects > Rasterize
Layer > Flatten Image

This will also remove trails from meteors, satellites and planes that appear on some of the frames but not others. If the alignment isn't perfect you will to get some softening when using this stacking method; compare it to just doing noise reduction on a single image in the raw converter and then in Photoshop. Mac users can use an app called Starry Landscape Stacker to align several images.

Further editing in Photoshop:

Whether you did a single exposure or stacked several to lower noise, you will have a single layer that can be further edited in Photoshop as needed. If you have hot pixels you can remove them here – see below. If you got a good set of images in a dark sky you shouldn't need the heroic processing that you will often find on the web. Going too far will just bring out noise and other ugly details. The cleaner your original capture, the further you can go to extract tonal detail.

Color correction for the overall warm tone and lower contrast caused by city light pollution is best done in Photoshop with Curves rather than using the White Balance slider in the raw converter. Light pollution will be worse close to the horizon and you will need to correct it for that portion of the image and then mask it out with a gradient for the darker regions. Many people prefer to render the sky toward blue in Milky Way shots but a blue sky would only occur with some moonlight, and that will limit the detail you could record in the Milky Way.

A quick and easy way to correct the warm glow of light pollution is with a Curves adjustment layer. In the upper right of the adjustment dialog there is a small icon with four horizontal lines. Click it and you get a list of choices. Choose Auto Options and check Enhance Channel Contrast and Snap Neutral Midtones.

More sophisticated color correction is well covered by Roger Clark:
http://www.clarkvision.com/articles/astrophotography.image.processing2/

The Despeckle filter in Photoshop (Filter > Noise > Despeckle) can often take out some very fine noise. The Dust and Scratches filter in the same menu can also be good. Inspect the results at 100%.

Options for increasing tonal detail include Curves and some plugin filters from the Google/Nik suite, the Topaz filters or others. Be aware that bringing up tonal detail will generally emphasize noise. The only real cure for noise is not to record it in the first place.

There are some excellent actions for enhancing astro shots here:
http://www.prodigitalsoftware.com/Astronomy_Tools_For_Full_Version.html

Hot pixel removal with Canon cameras and Lightroom or Adobe Camera Raw:
Canon cameras (recent high-end DSLRs) that have a menu item for sensor cleaning have a feature that has been largely undocumented, where the camera creates a map of hot pixels. To keep it up to date, put the body cap on the camera or make sure the lens cap has no light leaks. Set the ISO you will be using for your night photography, put it in a dark room, go to the menu item for sensor cleaning, choose manual cleaning and leave it for about a minute. The hot pixel map will be automatically used by Lightroom or Adobe Camera Raw but it is not as perfect as using Long Exposure Noise Reduction.

For lenses that have quality issues in the corners (and almost every wide angle lens does) you can improve image quality in the corners by taking a number of overlapping shots and use a pano stitching program to compile the best parts of each, giving you a megapixel result in the bargain:
http://www.lonelyspeck.com/medium-format-astrophotography-with-panorama-stitching/

A good source of further information is Royce Bair's blog,
http://intothenightphoto.blogspot.com/
and I highly recommend his e-book, Milky Way Nightscapes.

Another source I really like is Alister Benn's e-book, "How to Photograph Landscape at Night," http://intothenightphoto.blogspot.com/

Below is an example of a Milky Way shot from a somewhat dark site with simple equipment. It was shot with a Canon 5D Mk III with the "classic" Canon 24-70 f/2.8 L

lens (not the new II version). ISO 3200, f/2.8 15 seconds. The processing is just the basic steps outlined above.

This isn't a good lens for stars but it is an example of an average one. Different lenses will perform differently and the rendering of stars will challenge the best lenses. The reviews on www.lenstips.com give examples of corner and edge quality with pinpoints of light at different apertures.