The Simplest Astrophotography

Great night-sky shots can be made with just a camera, lens, and tripod.

Go To mounts, autoguiders, and narrowband filters are all wonderful inventions — but a minimalist approach has its advantages. And taking astrophotos with just a camera mounted on a tripod is about as minimalist as it gets.

If you're travelling, this may be the only option available given airline baggage restrictions, and it might represent the limit of what you can carry in a backpack on a hike to a remote location. It's coincidentally the most budget-friendly approach. But there's also real joy in capturing compelling images using the absolute minimum amount of equipment.

Gearing Down

A basic setup actually requires careful pre-planning and employing a few "best practices" to ensure you can wring out every drop out of your gear's potential. To begin, let's consider your camera and lens settings. First, make sure your camera is set to shoot in RAW mode (not JPEG) for maximum flexibility during post-processing. Second, put your camera in Manual mode so you can individually adjust the three key exposure-triangle settings: shutter speed, lens aperture, and ISO.

The duration of your exposures is always limited when shooting the night sky with a fixed tripod. Due to Earth's rotation, the stars will appear to trail if you leave the shutter open too long. But how long is *too* long? Well, that depends on the focal length of your lens and which part of the sky you're photographing. Telephoto lenses will show trailing very quickly, while wide-angle lenses allow longer exposures.

▲ **STARLIGHT AND FIRELIGHT** Despite the smoke and light pollution from nearby wildfires, the sky was dark enough to allow photographs of the Milky Way (and Mars, the bright object to the left of the tree) at the Mount Kobau Star Party in 2018. The scene was captured in a single, 30-second, tripod-mounted exposure made with a Canon EOS 6D camera set to ISO 3200 and a Canon EF 15mm f/2.8 fisheye lens, used wide open.

ALL IMAGES BY THE AUTHOR

Stars near the celestial equator trail the most, and those near the poles trail the least.

For a camera with a full-frame sensor, you can estimate the approximate maximum exposure time (in seconds) by dividing 500 by the focal length of your lens. This is known as "the 500 rule." For example, a 50-mm lens will allow about a 10-second exposure (500 ÷ 50) before trailing becomes noticeable. For crop-sensor cameras, which usually have smaller pixels, or for tighter star images with any camera, use a value of around 300 instead. In such scenarios, that same 50-mm lens will be good for roughly a 6-second exposure. Reviewing your images at 100% magnification will reveal the maximum time you can use before the stars start to trail objectionably.

To gather as much light as possible you'll need to shoot with your lens wide open at its lowest f/stop setting. Each decrease in f/stop (for example, going from f/4 to f/2.8) doubles the amount of light gathered during each exposure. If your budget permits, consider upgrading to the fastest ultra-wide-angle lens you can afford. This will maximize the total amount of light you can collect during a single shot.

The optimum ISO setting is very camera-specific. Increasing the ISO won't capture more light, but it will produce brighter-looking images. Modern sensors display less noise at high-ISO settings than older cameras, so as a starting point try ISO 1600.

Once you've dialed in your initial settings, take a series of test exposures, ideally on a clear, moonless night. Experimenting with different combinations of ISO settings and shutter speeds will allow you to find the best compromise between image brightness and noise for your particular setup. You may also find that using your lens fully open results in unacceptably poor star images, especially near the edges of the field. If so, closing the aperture by a stop or more might be preferable even if it means sacrificing some light.

Getting all your settings dialed in correctly is important, but a fixed-tripod setup always has limitations arising from the necessarily short exposure times. But there are a couple of things you can do to improve your astrophotos without investing in additional equipment.

◀ **TAKING IT EASY** Aside from a camera and lens, a basic astrophoto setup consists of a sturdy tripod and (optionally) a remote shutter-release. Remote releases from camera manufacturers can be expensive, but third-party versions (such as the one shown here) function well at a fraction of the cost.

Getting More with Less

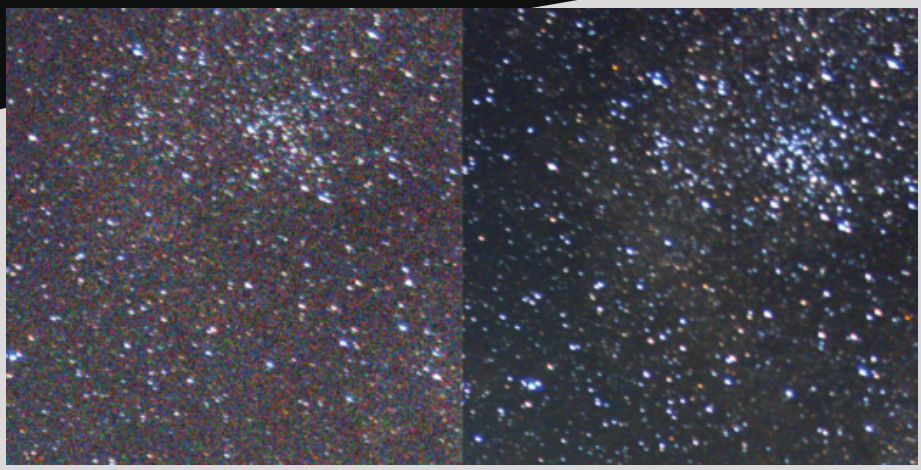
If you live in or near a big city, the first thing to try is a trip out of town around the time of new Moon — darker skies always produce better astrophotos. By shooting from a dark location, you can eliminate interference from light pollution, revealing fainter stars and the grandeur of the Milky Way. Check **lightpollutionmap.info** and seek locations far from populated areas. National parks and dark-sky preserves are the best options.

Another benefit to remote locations is that they often offer compelling landscapes that add visual interest to your images. Here's where ultra-wide lenses shine. They allow you to include a foreground scene while still capturing wide swaths of the night sky.

Stacking the Astro Deck in Your Favor

Every astronomical image requires some post processing to reveal all it has

▲ **BIG DIPPER TRAILS** As this 8-minute exposure shot with a 35-mm lens shows, even stars near the celestial pole show considerable trailing. The closer you aim your camera at the celestial equator, the more the apparent motion of the stars increases, leading to even longer trails.



▲ **NOISE POLLUTION** This 100% crop illustrates the benefits of digitally stacking multiple shots of the same scene. Compare the amount of sensor noise in the single, 10-second exposure (left) to that of a stack of 32 images (right). Low-noise photos are more attractive and allow much more extensive post-processing.

to offer. But the problem with short exposures is that they don't tolerate the amount of aggressive image editing that's usually required to produce a good image. One way around this is to shoot multiple exposures and add (or, "stack") them together before you begin your final edits.

For example, let's say you're using a full-frame camera with a 16-mm lens that allows 30-second exposures before the star trails become noticeable. Rather than taking just one image, shoot several 30-second exposures, one right after the other. And while the stars will shift slightly from frame to frame, you can align and merge the images later with software such as *Adobe Photoshop*, *Affinity Photo*, or *DeepSkyStacker*. Specialty programs like *Sequator* (*S&T:* Aug. 2022, p. 66) and *Starry Landscape Stacker* will even automatically align the foreground and sky separately.

Averaging the light value for each pixel across a large number of separate shots smooths out the randomly distributed digital noise. The final image these programs produce will have much less noise than any individual frame, allowing far greater latitude in post-processing.

Worth Repeating

How many shots is enough? Each incremental improvement in noise reduction requires a doubling of the number of shots. So, going from 4 to 8 exposures will give you a distinctly better image, but you'll need to double that again — for a total of 16 frames — to get an equivalent bump in quality. Use your own judgement to decide how many shots you need to take with your equipment to achieve results you like.

▲ **CONJUNCTION COMPOSITION** Tripod-mounted cameras using telephoto lenses are limited to very short exposures, but that's not a problem when shooting bright targets. This ¼–second twilight portrait captured with a Canon 70D DSLR (at ISO 3200) and 300-mm f/4 telephoto lens shows a conjunction of the Moon, Mars, and Venus.

If you plan on taking dozens of images, a remote cable release or intervalometer can make the process easier. Note that several modern digital cameras have built-in interval timers (check your manual to see if yours has this handy feature).

You'll need to adjust the position of your camera periodically to prevent Earth's rotation from carrying your target area off of the edge of the frame. Longer focal-length lenses will require repositioning frequently due to their narrow field of view, while ultra-wide lenses are much more forgiving.

You might wonder if you can avoid this entire process by taking only one image and then stacking multiple copies of it on your computer. Sadly, this won't work. As noted earlier, the stacking process relies on the fact that image noise is randomly distributed across each frame. Stacking a bunch of identical values won't get you anywhere — the noise will add up just as much as the light from the stars does. (Turn to page 54 of the April 2022 issue for additional details on how and why image stacking works.)

After you've loaded a set of frames into your computer, don't be surprised if the alignment and stacking process takes a while to complete. These are processor-intensive tasks that can require many minutes (or even hours), depending on the age of your computer and the size and number of individual shots. At the end of the wait you should have a single, well-aligned photo with very little visible noise.

As a final step, you'll want to apply some additional processing to bring out subtle details hidden in your stacked image. Unlike typical daytime photos, night-sky shots tax the limits of even modern digital cameras. The details are there, but they are subtle and will require some processing to reveal. But the results are certainly worth the extra time and effort involved.

■ TONY PUERZER is a retired professional photographer who loves the freedom of traveling to dark-sky locations with just a camera and a lightweight tripod.