Shooting "Deepscapes"

Here's how to capture striking photographs of deep-sky objects above landscapes in a single exposure.

Picture an image of the constellation Orion rising above a distant mountain, with M42 and the Horsehead Nebula displaying vivid colors and wisps of faint gas and dust. The reddish crescent of Barnard's Loop cradles the central stars of the Hunter's belt, spanning from Bellatrix to Saiph and back to Rigel. The large glow of Sharpless 2-164, the Angelfish Nebula, surprises you with its visibility in the photograph. Surely this must be a composite — such deep images are only possible using complex processing techniques to blend the moving sky with a stationary foreground, right?

Not so! While in the past such an image would have required hours of *Photoshop* wizardry, today's digital sensors and fast, high-quality camera lenses make deep-sky nightscapes such as this possible in a single short exposure. With planning, processing the images takes almost no time at all.

▲ Photographing deep-sky targets over terrestrial landscapes in a single exposure can be a worthy challenge. In this article, the author shares tips to capture deep images such as this shot of the Orion hourglass as it rises over mountains. The single, 35-second image was taken with a modified Canon EOS 6D DSLR and 85-mm lens at f/2.2, ISO 12800.

While it's common practice for nightscape photographers to blend several exposures to create a smooth, picturesque composition or add a foreground to a deep-sky image, I prefer the challenge of capturing deep nightscapes in a single exposure by coupling old-school photography techniques with the latest digital cameras. The results give me the satisfaction and sense of accomplishment that just don't come from composites. Here are some tips on shooting your own single-exposure "deepscapes."

ALL IMAGES PROVIDED BY THE AUTHOR

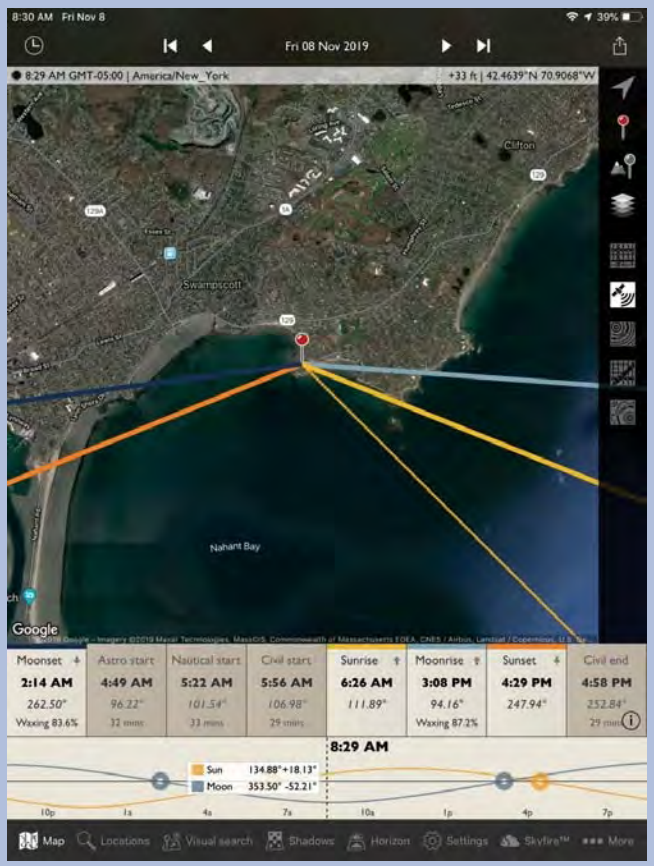
A Good Plan

The first thing needed to capture deep images of nebulae, galaxies, and star clusters over an attractive foreground is a firm knowledge of the night sky. Sure, the Orion Nebula, Andromeda Galaxy, or Magellanic Clouds are obvious deepscape targets, but there are many other objects that can expand your subject matter and add variety to your work. Virtually every major constellation offers something to focus on.

Knowing where an object will rise above the horizon can help you plan a composition before it's ready to photograph. A planetarium app can help give you a general idea of where an object is going to rise, but placing the sky in context to the landscape you intend to shoot requires more specialized tools.

Several apps are available to aid in planning your composition. *The Photographer's Ephemeris* (**photoephemeris.com**), *PhotoPills* (**photopills.com**), and *PlanIt!* (**yingwentech.com**) are some of the powerful tools available online or downloadable as Apple and Android apps that can help you to plan exactly where to position yourself so that your subject rises *precisely* above the foreground as you envisioned it. Most of these apps use built-in planetariums that combine a night sky map and a Google Earth view of your chosen location.

Transient objects such as comets require you to monitor astronomy websites to get up-to-date information about where these moving targets will be in your sky as they brighten enough to photograph in a single exposure.



▲ Apps such as *The Photographer's Ephemeris* help you plan your deepscape images by plotting the direction where specific targets will rise or set above the horizon based on your exact location.

Choosing a Lens

Deepscape photography is more challenging than typical nightscapes in that you often use telephoto lenses with narrower fields of view. This means that you can only shoot for a short time before your subject becomes noticeably trailed. But a good choice for starters is a high-quality, fast prime-focus 35-mm or 50-mm f/1.4 lens that produces sharp star images when used at its widest aperture. I recommend that you stop the lens down to f/2 to reduce aberrations in the corners of the frame. Stopping down the lens also reduces vignetting to nearly imperceptible levels. Most recent full-frame DSLR and mirrorless cameras have decent noise characteristics. But the newest models tend to incorporate the latest sensors, which produce excellent images at the extremely high ISO speeds needed to "freeze" the motion of your target over a landscape in short exposures.

A handy rule of thumb for nightscape photography is known as "the rule of 500." This states that for a fixed (non-tracking) camera, 500 divided by the focal length of your lens in millimeters gives the length of an exposure in seconds before stars appear trailed in your image. (And that also applies to the appearance

▼ High-quality, fast lenses such as Sigma's Art lens series combined with the latest sensors will produce your best results.

of your foreground when the camera is tracking the sky.) For example, when shooting with a 35-mm lens, you can expose for about 14 (500/35 = 14.29) seconds before stars are visibly trailed in a photo. This is not an exact rule, as the trailing will depend somewhat on the pixel size in your camera, what part of the sky you are shooting, and whether you use a full-frame or crop-sensor camera. But it should be close enough that stars and deep-sky objects will appear relatively sharp and stationary.

▲ Longer exposures are possible when adding a tracking head to your camera and tripod. Models that include a ½ sidereal rate (0.5×) will double the exposure time you can achieve before stars appear trailed in a photo.

A lens with a large maximum aperture (small f/ratio) delivers more light to your sensor and reduces the needed exposure time, especially when using a telephoto lens to image deep-sky objects. Most zoom lenses aren't well-suited for extreme low-light photography, because they are often not as fast as a prime (fixed-focus) lens and often not as sharp at the ends of their zoom range.

With lens speed and the rule of 500 in mind, portrait lenses are excellent optics for capturing single-shot deepscapes. These lenses range from focal lengths of 85 to 135 mm. Canon, Nikon, and several other manufacturers produce excellent portrait lenses, and don't be afraid to shop for older, manual-focus lenses on the used market. I recommend Sigma's Art lens series as my most frequently used lenses for short deepscape images. They work quite well at full aperture.

Portrait lenses can reveal a surprising amount of detail in deep-sky targets. Nearby spiral galaxies start to display their spiral arms in exposures of as short as 20 seconds at high ISO. Many of the nebulae in Orion, including everything within Barnard's Loop, can be comfortably framed with a foreground object with a 135-mm lens on a full-frame camera.

For more resolution, you can step up to a 200-mm f2.8 lens or even longer. At this focal length, the Andromeda Galaxy (M31) shows its dust lanes, and larger globular clusters like Omega Centauri begin to resolve into individual stars.

Bending the Rule

As mentioned above, the 500 rule gives you the maximum exposure to avoid trailing stars. But this rule isn't set in stone. A silhouetted mountain peak against the sky won't look noticeably blurry in a short, tracked exposure, so you can track at full speed and go four to five times longer than the 500 rule recommends without losing foreground detail.

When shooting fields far from the celestial equator, you can increase the exposure because stars don't appear to move as much. For instance, midway between the celestial equator and poles, you can increase the exposure length by about 40% and still have acceptable stars. And you can expose areas near the celestial poles, such as the Big and Little Dipper asterisms, up to 70% longer.

Without tracking, you'll quickly realize the 500-rule exposure limit is too short with a telephoto lens to adequately record most deep-sky objects. Take the 85-mm lens, for example. The rule of 500 limit with this lens is only about 6 seconds. The obvious solution is to attach the camera to a tracking mount to follow the target as the landscape moves below. In normal deep-sky astrophotography, this allows you to expose as long as you can to improve an image's signal-to-noise ratio. However, our goal is to capture both the sky and objects here on Earth, so tracking for long periods blurs the foreground. The challenge is to reveal the celestial object in only a few seconds at extremely high ISO settings such as 6400 or more. One solution is to use a tracking mount that includes a ½ sidereal speed tracking rate. This trick splits image trailing between stars and the landscape. Using this tracking rate, you can effectively double the exposure limit. Our new rule of thumb for exposure then becomes 1,000 divided by the lens focal length.

Even so, this may be still too short to record dim objects, particularly when the foreground has interesting details to capture. One trick to overcome landscape blurring on nearby foreground objects is to illuminate them with a flashlight briefly at the start or end of the exposure. They only need to be lit for a moment or so and then remain dark for the rest of the exposure, freezing their motion in a tracked exposure.

One issue with shooting at full aperture on a fast lens is

◀ Balancing colorful deep-sky objects with lots of detail (such as the Carina Nebula, NGC 3372, seen here) with interesting foreground objects requires advanced planning. This shot was taken from the Atacama Desert in Chile using a 200-mm lens at f/3.5 paired with a Nikon D810a DSLR camera and tracked with the Vixen Polarie mount seen above. Total exposure was 25 seconds at ISO 12800.

a shallow depth of field — objects closer than the point at which a lens is set to focus will be noticeably blurred.

There's a great old-school technique you can use to overcome this issue. It works best with lenses that include a marked focal distance scale as well as a manual aperture ring. First, focus the lens on the foreground object of interest and illuminate it with a flashlight briefly at the beginning of the exposure. Then quickly but gently turn the focus ring of the lens manually to the marked infinity point on the lens, and let the exposure finish up. In the resulting image, both the stars and the illuminated foreground will appear sharp. If your camera is mounted on a sturdy tripod, you can experiment with stopping down the aperture of the lens at the start of the exposure to ensure the nearby subject is as sharp as possible, briefly light it up, then open the aperture and move the focus to infinity.

▶ "Painting" in foreground objects at the start of an exposure using a flashlight will help balance your composition, as was done with the ALMA radio telescopes seen beneath the Large Magellanic Cloud in this photo.

▼ This group of ALMA radio telescopes below the Coal Sack and Southern Cross was taken by first focusing on the telescopes, quickly illuminating them with a flashlight, then changing the focus to infinity to record the stars and constellations all in the same exposure.

This focus-ramping technique is tricky to perform, particularly in the dark, so you'll need to practice it few times to ensure you get it right.

Camera and ISO Speed

This type of complex nightscape photography requires a detector suitable for low-light imaging regardless of the ISO setting used. Changing the ISO setting in your camera amplifies the signal recorded, increasing noise as well as the signal recorded, and is not a replacement for a high-sensitivity detector. The true sensitivity of a CMOS sensor is directly related to the size of its individual pixels. These tiny wells collect photons like buckets collect raindrops — larger pixels collect more photons before filling up (saturating) than small pixels do. Cameras using APS-sized detectors with more than 30 megapixels sound astounding but use tiny pixels that saturate quickly, which translates into white, colorless stars after post-processing. Full-frame cameras are better suited for deepscape imaging because they incorporate larger pixels in a bigger detector, and thus saturate at a much higher threshold.

Recent camera models designed for astrophotography such as the Nikon D810A and the Canon EOS Ra both utilize 30+ megapixel full-frame sensors with about 5-micron pixels. Although 5-micron pixels are a bit small, they are paired with powerful internal processors that finely control noise in images taken at high ISO speeds.

The benefit of these Canon and Nikon cameras is their spectrally enhanced internal filters which, compared to standard cameras, pass a larger percentage of the hydrogen-alpha (Hα) light that most nebulae emit. Since most deepscape targets include a lot of Hα, a spectrally enhanced camera will produce your best results. You can shop for one of these newer cameras, though several companies offer services to modify older DSLR and mirrorless cameras to pass more of this astronomically important wavelength.

Challenging Skyglow

Deepscape photography by its very nature often requires shooting your subject close to the horizon where distant skyglow is more evident. Even in a totally dark sky, an atmospheric phenomenon known as *airglow* may visibly brighten the background sky, imparting an orange or greenish glow that obscures your intended subject. Skyglow or light-pollution filters can suppress the sky brightness and increase nebulae contrast, but keep in mind the image will need more exposure to overcome the reduced signal. Skyglow filters are more impactful with modified cameras.

Using additional filters can also impart a color cast to your photos that is best corrected by setting a custom white balance in your camera. This is accomplished by setting your camera color setting to auto (AWB) and photographing a gray

◀ Some foreground subjects will not detract from your final image even if they are blurred. The cloud deck below the peaks on the Canary Islands adds a mystical quality to this tracked photo of nebulosity in Sagittarius and Scorpius.

▲ Depending on the subject you are shooting, the stars don't always need to be in focus. In this case, these nightscape photographers are the focus of the composition.

card or a piece of white paper in daylight with your intended filter in place. Make sure the card or paper completely fills the frame. Then simply change the color setting to Custom White Balance and select this photo as the calibration image. Be sure to keep this photo on your memory card when shooting deepscapes, and to use the custom white balance setting.

Processing the Results

Once you've shot your images, a little post-processing is necessary to achieve the best results. It's important that you shoot in RAW mode to get the most out of your night's work. I prefer to use *Adobe Lightroom* and *Adobe Camera Raw* (ACR), though Nikon and Canon offer their own processing programs that can accomplish much of the same enhancements.

My first step is to reduce noise in the image by opening it in ACR and first lowering the Texture slider by around 20. I select the Detail tab in the right column. Rather than adjusting the Luminance slider in the Noise Reduction area, I prefer to lower the Sharpening setting. Masks can also be applied to target certain areas for additional noise reduction after applying ACR, adding a layer mask over the areas you'd like to target and repeating the ACR process. Next I change the color profile in the Basic tab to Adobe Standard, which slightly increases contrast and saturation. If necessary, I'll increase the Contrast and Vibrance sliders.

If I shot my deepscape at maximum aperture, I'll select the Lens tab and find the lens I used from the extensive pulldown menu, which corrects for vignetting and chromatic aberration in many lens designs. Other settings that can improve an image are the Shadow and Highlight sliders, which help to bring out faint nebulosity or suppress bright areas in a picture if necessary. The Dehaze slider is very powerful in increasing contrast in an image but requires restraint so as to not "overcook" the result.

If you shot under light-polluted conditions, you can correct the white balance in the Basic tab. Keep in mind that shifting the color slider to low temperatures in order to remove the orangish cast of light pollution from the sky background will also shift the colors of the stars, Milky Way, and other celestial objects.

Using these tips, you too can shoot captivating deepscapes that bring your favorite deep-sky objects down to Earth.

■ Contributing Photographer **BABAK A. TAFRESHI** captures the beauty of the Earth and sky from exotic locations worldwide. See more of his work at **babaktafreshi.com**.

▼ *Left:* Unilluminated foregrounds like the mountains seen here below nebulosity in Scorpius won't display much blurring in longer exposures, so you can expose a deepscape for roughly four times as long. This image was captured with a Nikon D810a camera and a 105-mm lens, and tracked for 25 seconds at ISO 12800. *Right:* Slight illumination on the arc limited this exposure to 15 seconds at ISO 6400 with a 50-mm lens at f/2.8.