Bright-Sky Imaging

THERE ARE PLENTY OF THINGS TO SHOOT UNDER MOONLIT AND URBAN SKIES.

DON'T FEAR THE MOON A nearly full Moon or even light pollution shouldn't keep you from taking advantage of clear skies. Author Ron Brecher shares some tips on making the most out of less-than-ideal conditions. Unless otherwise noted, all images are courtesy of the author.

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The Moon is full about every four weeks; that's a given. Within about a week either side of full, the Moon floods the night sky with reflected sunlight. This can be, among other things, beautiful, romantic, eerie, tranquil, or even photogenic in its own right. But it creates real challenges for deep-sky astrophotography. Even when there's no Moon, skies near even small cities may be plagued by light pollution. High humidity or particles in the air can make matters worse, with light scattering making the sky even brighter.

So what's a dedicated deep-sky imager to do? Take a deep breath. Think things through. Then work to make the best of the situation.

Much like man-made light pollution, the Moon's light washes out many faint objects, especially dim galaxies. Since I'm not willing to surrender two weeks of deep-sky imaging to the Moon every month, and light pollution is all around me, I've developed a few strategies to keep the shutter open even under less-than-ideal conditions.

Location, Location, Location

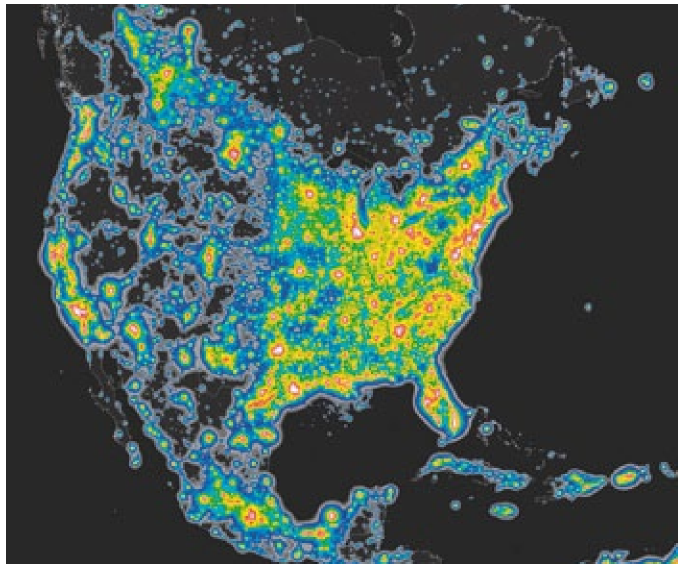
One effective strategy is to choose targets in the darkest part of the sky. When the Moon is near first quarter or last quarter, I can usually find some pretty dark areas of sky in the north, especially on very transparent nights when there are fewer particles in the air to scatter moonlight. The Moon follows a more southerly path through the ecliptic during the summer, so it's farther away from more northern target areas in summer than in winter (though the nights are so short!). By shooting on transparent nights and shooting objects only when they're near the meridian (say, 2 hours on either side), one can minimize the effects of light pollution and lunar glare.

If you have a portable imaging rig, try to pick a setup location in the shadow of trees or a building. This will help to keep direct, intense moonlight from entering your optic. Choosing a northern target when imaging in the Northern Hemisphere (or a southern target when imaging from south of the equator) will also help keep the Moon from shining on the inside of your optical tube or dew shield.

Star Clusters and Nebulae

Another way to get the most from bright skies is by choosing targets that still show well through the glow. Open clusters and globular clusters are my objects of choice under a bright Moon, especially if I want to acquire an entire color image data set in one session using a monochrome camera with color filters. Compared to galaxies and nebulae, star clusters are often overlooked by imagers, yet they each have their own appearance and unique character while adding variety to your imaging portfolio. They also make great targets for checking the performance of your telescope across the entire field of your sensor.

Some choice clusters in the fall and winter months include NGC 7789, sometimes known as Caroline's Rose Cluster, located just east of Beta (β) Cassiopeia. It's quite large and colorful, and a fine open cluster to target. Another splashy open



▲**BRIGHTENING SKIES Top:** This map shows the intensity of light pollution in the United States, with white denoting the strongest concentrations. **Bottom:** Open clusters, including NGC 457 seen at middle, make great targets even in bright skies. Stacking many short exposures will keep the background from getting too blown out.

TOP: F. FALCHI ET AL. / *SCIENCE ADVANCES* 2016

cluster is M35, and it contrasts well when framed in the same field with the more distant cluster NGC 2158.

Many globular clusters are well-placed targets during the summer and autumn months in the Northern Hemisphere. Choose a bright one high in the northern sky, far from the ecliptic, like M5, M13, or M92. Careful processing can bring out even the faint outer reaches of these objects and reveal beautifully colored stars.

Other Bright Targets

Small, bright planetary nebulae, as well as some emission nebulae, can be captured well in a bright sky and found on most any night of the year. Targets like M42 (the Orion Nebula), M57 (the Ring Nebula), and M27 (the Dumbbell Nebula) are bright enough to punch through moderate light pollution and moonlight, even without using narrowband filters. And don't be afraid to target nebulae that lie very close

▲ **FULL OF STARS Top:** Globular clusters, such as M10 seen here, also make fine targets under most any skies. **Middle:** Planetary nebulae can easily punch through moderate light pollution. The full Moon was up while recording most of the narrowband data used in this composite of M27. **Bottom:** Shooting nebulae through narrowband emission-line filters (including Hα, O III, S II, and N II) greatly reduces the impact of light pollution and moonlight in deep-sky images. This color composite of NGC 6960, the western side of the Veil Nebula, reveals plenty of reddish Hα and teal-colored O III.

to a bright star, such as IC 59 and IC 63, which are tucked up very close to Gamma (γ) Cassiopeia.

Comets are another class of targets to watch for in less-than-ideal conditions. If you get the chance to catch a nice bright comet against a field of background stars or a star cluster, take advantage of it. Comets come and go very quickly with very little warning, and they may be out of sight or in a less interesting field before conditions become ideal for a better shot. Many comets are at their best in twilight, when bright skies are unavoidable.

Galaxies may be the toughest objects to capture under bright skies. The majority are small, dim, and fuzzy. It's best if you can wait for (or go to) a darker sky to shoot them, but if that's not an option for you, then try to shoot plenty of images and process them carefully to tease out the faintest outer details. As in all astrophotography, excellent focus is critical. In bright skies, it's even more so, because good focus gives the maximum possible contrast both in stars and extended objects.

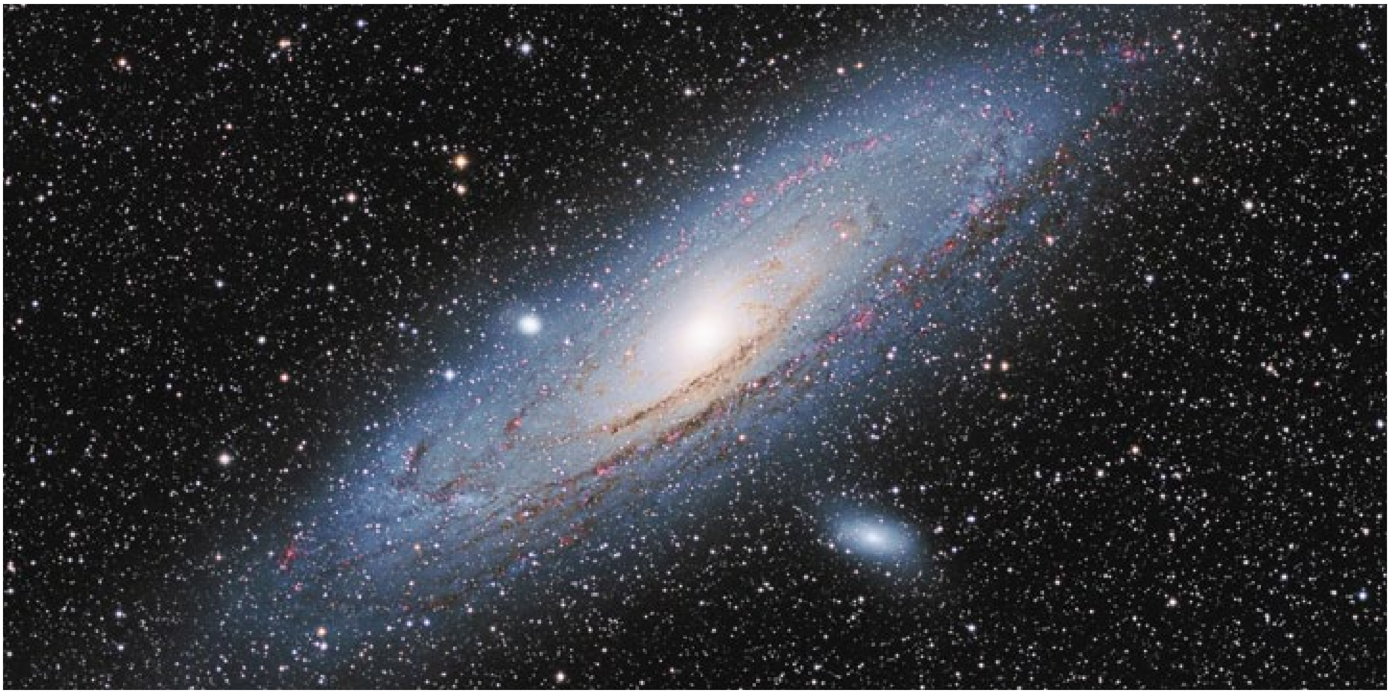
The Narrowband Solution

A popular deep-sky imaging solution to both moonlight and light pollution is to shoot with a monochrome camera through narrowband filters. These filters block all light except for a narrow range of wavelengths — roughly 3 to 10 nanometers wide — where specific elements emit visible light. These strips are known as emission lines. Narrowband filters (particularly hydrogen-alpha, or Hα) have the added benefit of blocking most sources of strong light pollution as well as moonlight, permitting users to image on practically any clear night of the year. Narrowband filters are most effective when shooting emission nebulae, including most of the bright nebulae on the Messier list, as well as planetary nebulae. They're ineffective on reflection nebulae, though. These filters can also be used with one-shot color cameras, including DSLRs.

I tend to shoot a mix of both natural color (RGB) and narrowband data to take advantage of most any clear skies I get. My color pictures are often made up of data recorded through five filters — typically red, green, blue, Hα, and doubly ionized oxygen (O III). I usually wait for a transparent and moonless night to shoot my broadband red, green, and blue images, and often shoot Hα and O III data when the Moon is up.

Notice I don't use a clear (luminance) filter. Rather, I synthesize a luminance channel by combining all my other filtered shots into a monochrome result that can be used as a luminance image. I've found that the luminance filter is more severely affected by light pollution and moonlight than the individual color filters, so I tend to get a better result this way.

This approach works particularly well for planetary nebulae and emission nebulae, since much of their light is emitted in the same narrow ranges of wavelengths passed by narrowband filters. In addition to the bright targets mentioned earlier, you can go after some fainter quarry off the beaten path using narrowband filters. The Sharpless catalog contains many emission nebulae perfect for scopes of all sizes. A good resource for choosing targets from this catalogue is Dean



▲ **GALACTIC ENHANCEMENT** Galaxies are perhaps the hardest target to shoot under bright skies. However, some nearby specimens, such as M31 seen here, contain many small H II regions that can be captured well through a Hα filter even in a light-polluted sky or when the Moon is nearly full.

Salman's gallery found online at **sharplesscatalog.com**. It lists objects by constellation and provides information on each object's size and brightness, with notes to suggest what filters might work best.

Short Exposures

When shooting under light pollution or moonlight, you'll need to record shorter exposures (and many of them) than you can in darker conditions. This is because the bright sky saturates your camera's detector quickly, washing out your target before you can capture enough photons in a single exposure. Stacking many short images also does a better job of removing artifacts and other unwanted signal in individual frames, including airplane and satellite trails.

In bright conditions, I often shoot exposures of about ⅓ to ½ of what I usually use in more ideal conditions. For example, I usually take 10-minute exposures with red, green, and blue filters on a dark night. With the Moon up, I typically shoot 5-minute exposures. These shorter exposures have a lower background brightness with more dynamic range between the darkest and brightest pixels in the image compared to a long exposure under the same conditions.

Banishing Gradients

Once you have your images recorded, one of the first processing hurdles you'll encounter is eliminating brightness gradients. Images recorded under brightly lit skies will inevitably capture unwanted brightness gradients along with the precious photons that we're really after. Fortunately, most image-processing software these days includes tools that can reduce the impact of unwanted light gradients in images. I use *PixInsight*'s DynamicBackgroundExtraction and AutomaticBackgroundExtraction tools to address these problems, which is one of the first steps in my deep-sky image processing workflow (*S&T:* August 2016, p. 66). Another option is the plug-in tool for *Adobe Photoshop* called *GradientXterminator* (**http://is.gd/zryU32**), which is an effective and easy-to-use solution after converting your image to TIF format. There are also many online tutorials describing gradient removal methods for other image-processing software.

Strategies for Success

Most amateur astrophotographers know that there's a sort of "Drake equation" for the probability of getting in a good night of imaging. And the news isn't good. For most of us, astrophotography is limited due to clouds, wind, work, family commitments, and pesky equipment malfunctions. But with a few carefully chosen strategies, you can stop the Moon from robbing half of your imaging time every month and mitigate the impact of light pollution on your results. Use the brightest nights — whether from moonlight or light pollution — to make sure your equipment is in top shape for those clear, transparent, and moonless nights that we all crave. Target objects that outshine your local light pollution, or simply take test shots to help you frame new targets. Taking these steps can greatly expand the number of nights you can be out collecting photons, rather than letting your equipment sit idle.

■ **RON BRECHER** shoots deep-sky targets from his backyard observatory in Guelph, Ontario. Visit his website at **astrodoc.ca**.