



Create your own colorful nebulae images with this helpful technique.

▲ **DAZZLING COLOR** Shooting brilliant images of nebulae is within the reach of urban imagers using monochrome cameras equipped with narrowband emission-line filters. This composite image of the Pelican Nebula, IC 5070, was recorded by Michael Miller through a Stellarvue SV152T refractor and processed in *PixInsight* by Warren Keller.

||| **SOME OF THE MOST DRAMATIC VIEWS** of celestial objects seen today have been created using the technique of narrowband imaging. Instead of combining individual frames taken through red, green, and blue filters, photographers employ filters that isolate the wavelengths of light produced by ionized gases in emission nebulae. False-color photographs assembled from images taken through these filters are much more colorful than natural-color images.

Narrowband imaging also allows urban imagers to pursue deep-sky astrophotography in light-polluted settings. The extremely narrow passbands of emission-line filters block most of the wavelengths produced by streetlights and other artificial

illumination (as well as by moonlight). This allows you to reveal ionized gases that permeate the Milky Way and other galaxies from even badly light-polluted areas.

It's no wonder that narrowband imaging has grown so popular, and there are tools to help get the most out of this technique. Here's how you can assemble your own in the popular software *PixInsight* (pixinsight.com).

While several narrowband filters exist, those isolating the wavelengths of hydrogen alpha ($H\alpha$), doubly ionized oxygen (O III), and singly ionized sulfur (S II) are most commonly used by amateur imagers. We'll use frames taken through these filters to create a three-color image by assigning each channel in a descending-wavelength order — an approach popularized by scientists using the Hubble Space Telescope and known today as the “Hubble palette.”

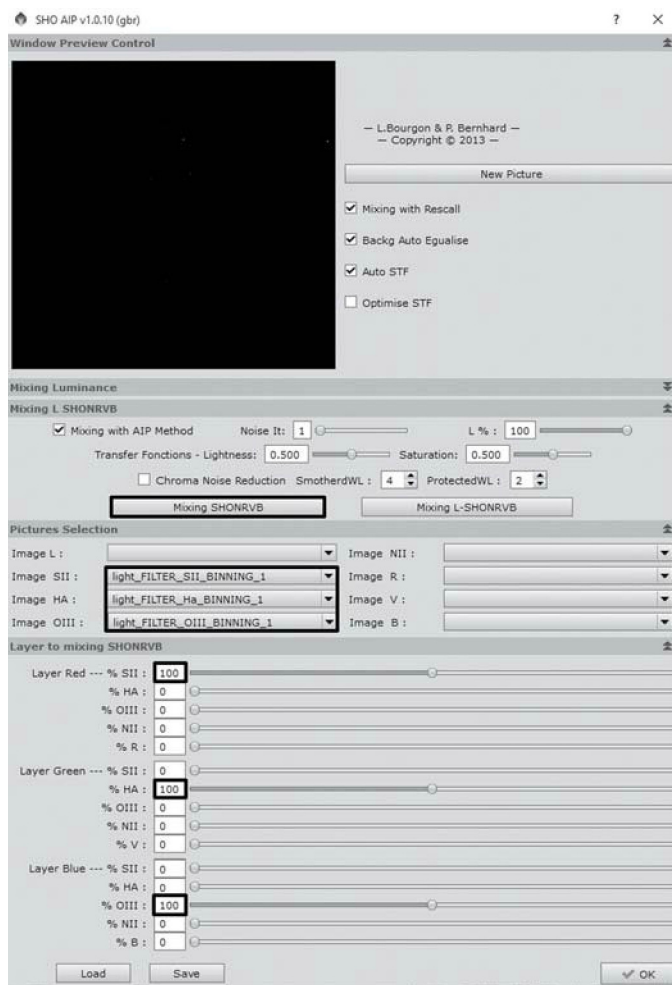
Scripting Color

As with most deep-sky CCD image processing, you should calibrate, align, and combine all your individual exposures into single master files for each filter used. Once completed, you can then begin to assemble them into a color image using *PixInsight*'s powerful Script functions. My preferred technique begins by opening the master $H\alpha$, S II, and O III images, then opening the SHO-AIP script found in the script pull-down menu (SCRIPT > Multichannel Synthesis > SHO-AIP). The letters SHO stand for sulfur, hydrogen, and oxygen, while AIP is the group that developed the script. This script uses the Hubble palette mentioned earlier as its default palette, in which S II is assigned to the red channel, $H\alpha$ to the green channel, and O III to the blue channel.

Once the script is opened, assign your master files in the Pictures Selection section accordingly. The next step is the Layer to Mixing SHONRVB section, an acronym for Sulfur, Hydrogen, Oxygen, Nitrogen, Rouge, Vert, Bleu. As the SHO palette is selected by default, note that 100% of the S II master is mapped to “Layer Red”. Likewise, $H\alpha$ is assigned to “Layer Green”, and O III chosen for “Layer Blue”. But you can easily create alternative narrowband palettes by moving the slider controls to change both the channel assignments and contribution amounts of the master files to your liking.

At this point, direct your attention to the check boxes at the top right of the script dialog. The most critical setting is to check the Auto STF box. Those having some familiarity with *PixInsight* know that when viewing linear data, the STF (Screen Transfer Function) AutoStretch must be turned on to see an unstretched, dark image. The other three options might require some experimentation, but for best results try checking Mixing with Rescall (meaning rescale), and Backg Auto Equalise (Background, Equalize), leaving the Optimise STF box unchecked.

Now you're ready to create a color image from the three grayscale masters. This is done in the “Mixing L SHONRVB” section — click on the line to expand its dialog. Leave all the default settings in this section, and click the Mixing SHONRVB button to produce the color image. Should you



▲ **COLOR SCRIPTING** *PixInsight*'s SHO-AIP script lets you blend monochromatic, narrowband master files into a color image.



▶ RAPID RESULT

This view of IC 5070, the Pelican Nebula, exhibits a strong green bias and magenta stars — a typical result of using the Hubble palette combination before adjustment.

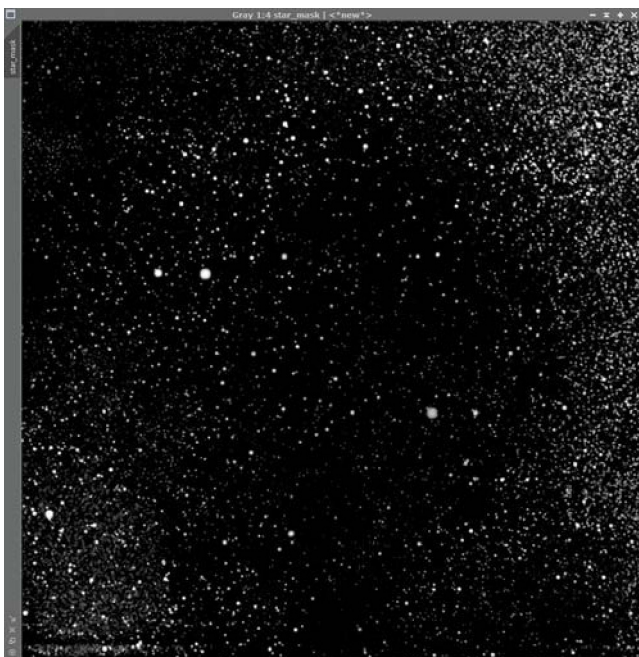
wish to try a different mix but keep the original result, click the New Picture button at the top of the window before clicking the Mixing SHONRVB button a second time.

While the resulting image is a good start, you might notice two artifacts of the SHO palette. First, it appears predominantly green. This is because $H\alpha$ is almost always the strongest wavelength generated by emission nebulae. Since the SHO palette assigns $H\alpha$ to the green channel, green overwhelms the relatively weaker contributions of the red and



▲ **CORRECTED COLOR** The ColorMask script helps to correct the green bias that's typical in a color narrowband image.

blue channels. You can adjust this later. Second, the larger stars might have magenta-colored halos. This is because the red and blue channels have been overstretched in an effort to match the green channel's strength (red + blue = magenta). If this bothers you from an aesthetic point of view, you can adjust this later, too. Also, if you've acquired a few images of the star field with broadband red, green, and blue filters, you can replace the narrowband stars with the naturally colored ones. Before leaving SHO-AIP and addressing such matters, let's look at another ability of the script.



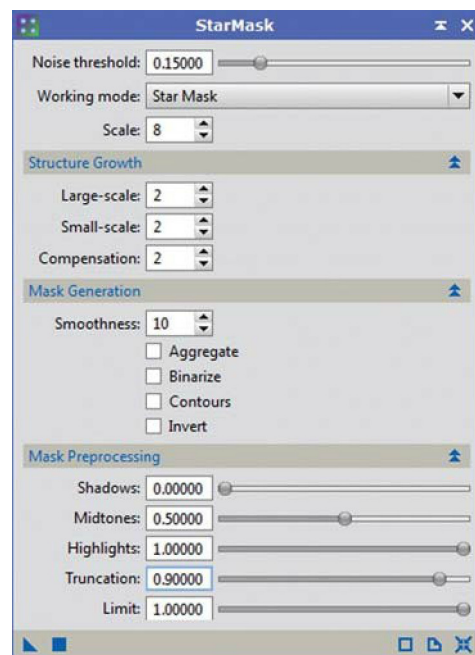
Synthetic Luminance

You might already be familiar with the concept of an image called "pseudo luminance," also known as *synthetic luminance*. This is a grayscale version created from the lightness properties of a color image. Comprised of the combined signal of all three color channels, a synthetic luminance is used to complement the color image, much in the way that a true luminance adds contrast and detail to an RGB image. The SHO-AIP script can produce a synthetic luminance from the color image, and you can do so immediately after creating the color image by first clicking the New Picture button.

To proceed, expand the Mixing Luminance section. Here you can order the masters of S II, H α , O III, but the sequence doesn't matter since the percentage slider controls at right control the mix. If you want to create a synthetic luminance comprised of all three master channels, click "Create L With master 1+2+3." Or, if only two channels contain the majority of the desired signal, choose "Create L with master 1+2." The blend method can be either Lighten, or possibly Screen when a brighter result is desired. Once your luminance is generated, click OK at the bottom right. While the script is also capable of combining the synthetic luminance and color image, this is best done later after both have been non-linearly stretched.

From this point, linear post-processing of the image might involve using the BackgroundModelization process to eliminate uneven illumination across the field. You can also use deconvolution to sharpen detail and tighten the stars, and linear noise reduction before a nonlinear stretch is applied (S&T: Nov. 2013, p. 72).

Earlier, we noted the green bias of your image. While *PixInsight* offers several tools for adjusting color, another script is particularly useful for this task. The ColorMask script by Australia's Rick Stevenson is nothing short of



★ STAR MASKS

Using the StarMask process allows you to isolate the stars in your image (far left) to correct magenta halos often seen in color narrowband images.

terrific. Although not yet included in *PixInsight*'s standard release, you can download and install it from the PI Forum (tinyurl.com/zfkuzgz). Select your color image and open the script. Now simply choose the desired mask by clicking the appropriate color button — there's rarely any need to change the other default settings. Press the OK button, and the script will produce a mask with the selected color range. Once the mask is applied to the image, you can adjust that specific range of color using the CurvesTransformation process (PROCESS > IntensityTransformations > CurvesTransformation). In iterative applications, green, cyan, and yellow masks are produced and applied one at a time. Use the CurvesTransformation's individual color channels to adjust the image. The image at the top of page 38 shows the result of reducing the green bias while increasing magenta and cyan until I was satisfied with the overall appearance.

Focusing on Stars

Now let's address the magenta halos around the stars. These can be repaired in a couple of ways. As mentioned earlier, they could be replaced with natural color from a typical RGB image. For now, let's try taking a simpler tack using *PixInsight*'s adjustments. While a magenta mask produced with the ColorMask script might facilitate this, you'll get a more targeted result using the StarMask process (PROCESS > Mask-Generation > StarMask). In the process window, try increasing the Noise threshold slightly and increase the Scale value to 8, the Small-scale value to 2, then lower the Smoothness value to about 10 and the Truncation slider to about 0.9. Then press the Apply button at the bottom left of the window.

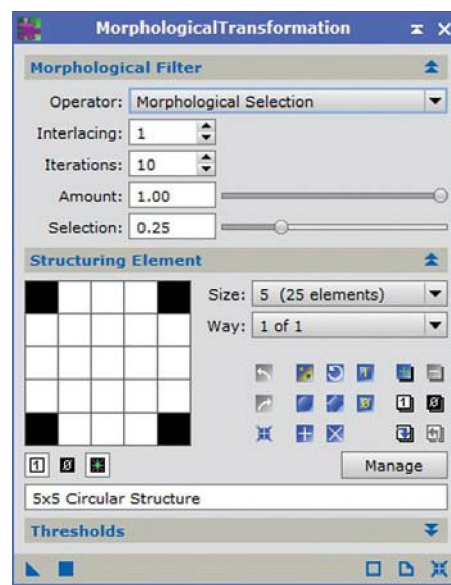
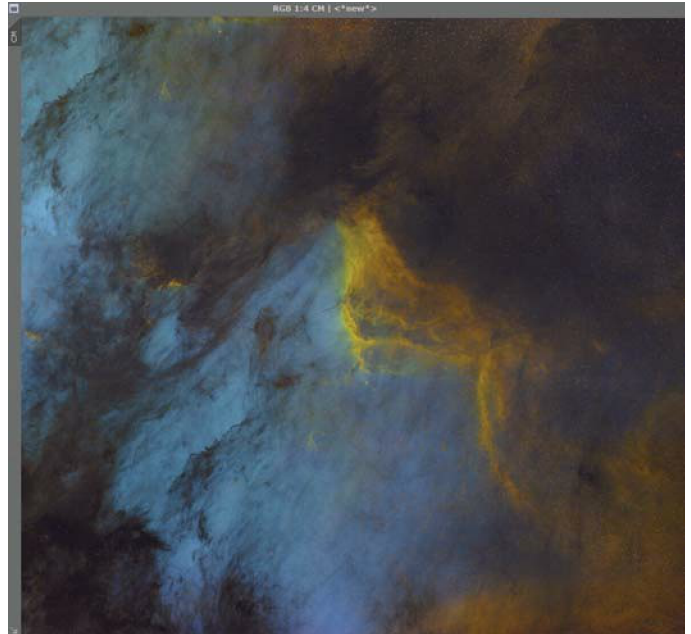
The resulting mask should appear black and white. You can apply it to your image by opening a context menu with a click of the right mouse button, then selecting Mask/Select Mask, and choosing the desired mask from the drop-down menu; only the stellar components are selected (indicated by the white circles). From there, you can reduce the saturation of the magenta star halos using the CurvesTransformation process's Saturation option. You could also alter the magenta hue using the finer control of the ColorSaturation process.

Another option is to alter the size and contribution of the stars. With the same star mask in place, use the Erosion setting in the MorphologicalTransformation process to reduce the stars' sizes — or even eliminate them completely.

With color adjusted to your liking, you could enhance the synthetic luminance image further with a host of contrast and sharpness-enhancing processes. The LocalHistogramEqualization process can be applied for a subtle yet effective improvement in contrast. The wavelet-based Multi-scaleLinearTransform and UnsharpMask processes would be more effective for sharpening small-scale details.

Bringing It All Together

To re-integrate the synthetic luminance with the color image, select your color image and open the LRGBCombination process (PROCESS > ColorSpaces > LRGBCombination). In this



STAR REMOVAL

You can use StarMask to virtually eliminate the stars in an image and thus reveal more small-scale structure within the nebula.

process window, select your stretched synthetic luminance in the L section, then uncheck the boxes to the left of the R, G, and B channels. You can perform some noise reduction by checking the Chrominance Noise Reduction box, and then click the Apply button at the bottom left. In a few moments, your new color image will appear, and you're all done.

In addition to tricolor (or even bicolor) narrowband images, narrowband data can also be combined with RGB data to produce hybrid results. In particular, hydrogen-alpha frames can be added to natural color images to enhance the H II regions of nearby galaxies such as M31 or M33. The possibilities of narrowband processing are endless.

■ **WARREN A. KELLER** is author of the new book *Inside PixInsight*, available through Springer (springer.com).