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We present some techniques for using mainstream graphics software, specifically **Adobe Photoshop**, to produce color images and illustrations from astronomical data. These techniques have been used with numerous images from the Hubble Space Telescope to produce printed and web-based news, education and public presentation products as well as illustrations for technical publication.

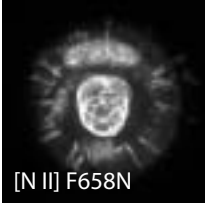
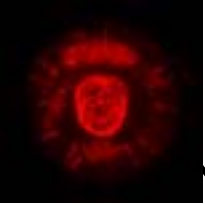
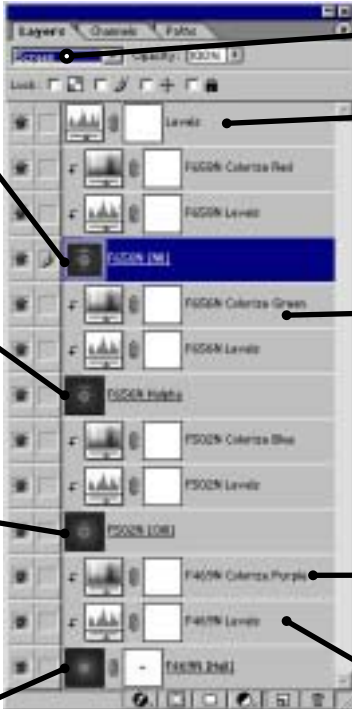
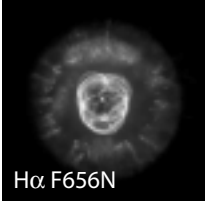
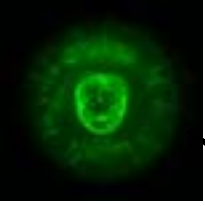

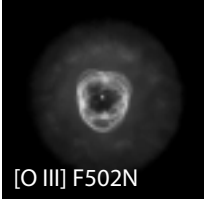
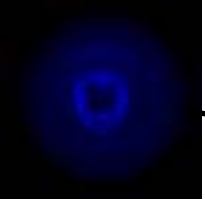

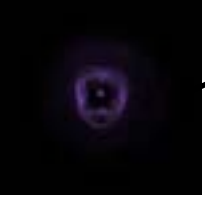
We have had much success applying Photoshop's numerous, versatile tools to work with scaled images, masks, text and graphics in multiple semi-transparent layers and channels. These features, along with its user-oriented, visual interface, provide convenient tools to produce high-quality, full-color images and graphics for printed and on-line publication and presentation.

#### **Note**

- Photoshop does not operate directly on full dynamic range data (such as 32 bit real FITS). It is necessary to scale such data to 8 bits per pixel per color (channel).
- Photoshop does support 16 bits per pixel per channel data but currently limits the range of tools and capabilities available for this depth.
- Analysis packages such as **IDL** and **IRAF** include tools to put images into a form recognized by Photoshop.
- The examples shown here were produced using Photoshop Version 6.01 on a PC/WindowsNT workstation. All of the features described here are available in several recent software versions on both Macintosh and Windows platforms.
- There is no up-to-date Unix version of Photoshop. The freeware GNU Image Manipulation Program (**The GIMP**) includes many of the same capabilities.

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# Composite Colors: Image Layers

Grayscale	Colorized		
		 <p>The Photoshop <b>Layers</b> palette for the color composite image.</p>	<p><b>Screen</b> layer blend mode, analogous to a projected transparency</p> <p>Global <b>Levels</b> adjustment layer applies to all layers below</p>
			 <p><b>Hue:</b> 130 (green)  <b>Saturation:</b> +100%  <b>Lightness:</b> -50%  <b>Colorize</b></p> <p><b>Hue/Saturation</b> dialog for the F656N (green) layer of the Eskimo Nebula color composite converts grayscale layer into single-hue color layer.</p>
			<p><b>Hue/Saturation</b> adjustment layer applies to the He II (purple) image layer</p>
			<p><b>Levels</b> adjustment layer, grouped with the He II (purple) image, applies to that layer only</p>

- Import separate grayscale images into separate Photoshop layers or a single RGB **TIFF** image with exposures composited into color channels.
- Any number of filters may be included, rendered in any color, to produce a color composite. In practice, fewer filters/layers produce more color separation.
- Three layers rendered in red, green and blue are equivalent to one RGB layer with the same images in red, green and blue channels.
- If the filter and rendered colors match the eye's response then a natural or "true" color image results. Otherwise, "false" colors, arbitrarily close to reality, will result.
- Colors may be "representative" if the rendered colors do not match the filter colors but are consistent with their wavelength order, ionization level, etc.

Resulting color composite image

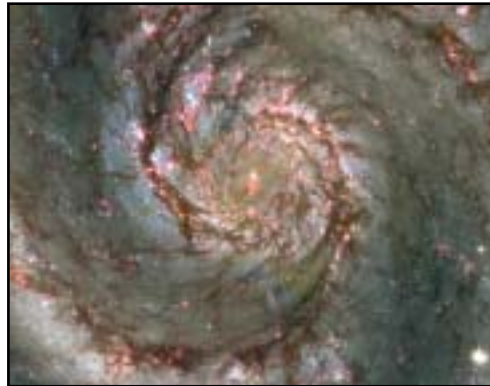


# Combining Differently-Processed Versions of an Image

Different “upstream” processing steps may be used to enhance certain features or attributes of an image. Square root, log, or other mathematical operations on the data may compress dynamic range, increase contrast in a particular brightness range, etc. These versions may be combined in

Photoshop, ideally to take advantage of the benefits of each processing method. While these mathematics may be accomplished within Photoshop, it is preferable to perform them on the full dynamic range data to prevent quantization artifacts.

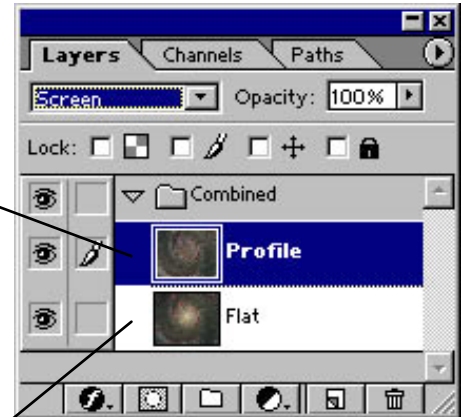
Color composite from exposures divided by a radially-symmetric profile to compress the dynamic range, suppress the bright galaxy nucleus and increase the contrast in the spiral arms.



“Straight” color composite from log-scaled exposures represents the brightness of the nucleus relative to the spiral arms of the galaxy.



M51 • HST/WFPC2  
Hubble Heritage Team (STScI/AURA)  
and N. Scoville (Caltech)



The Photoshop Layers Palette for the combined image. The upper layer uses “Screen” layer mode to “project” this image, combined with the lower layer.

M51 NGC 5194 • Hubble Space Telescope/WFPC2  
NASA and the Hubble Heritage Team (STScI/AURA)

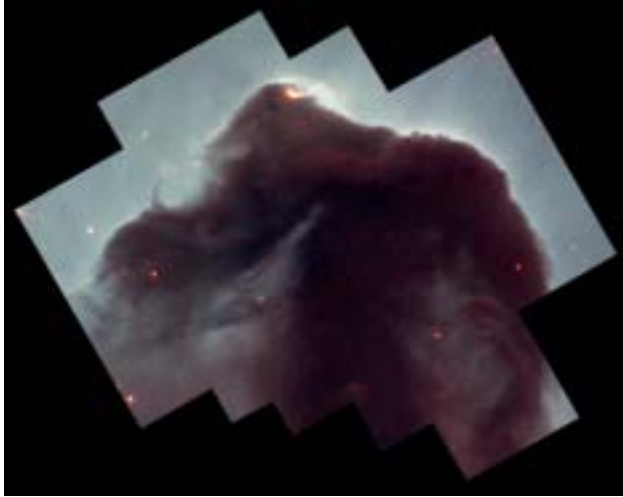


A combination of the two composites, showing the stronger delineation of the arms from the upper image, while preserving the larger brightness difference between the nucleus and fainter spiral arms represented by the lower image.

# Combining multiple images

Multiple images of the same field may be seamlessly (at least arbitrarily so) combined in Photoshop. This is useful to embed a higher resolution image into a wider-field view. Each image is in a separate layer. Semi-transparent layer masks permit regions of the upper layer to be rendered transparent, allowing the lower image to show through. Judicious feathering and painting of the layer mask permits merging the two images arbitrarily closely.

WFPC2 mosaic



NOAO image

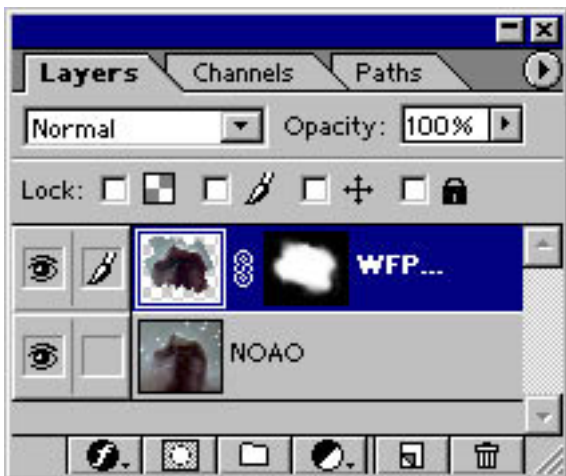


Mask for WFPC2 image layer



Composite image

Horsehead Nebula • Hubble Space Telescope WFPC2, NOAO  
NASA, NOAO, and the Hubble Heritage Team (STScI/AURA)



The layers palette for the NOAO/WFPC2 composite. A feathered, semi-transparent layer mask is applied to the upper (WFPC2) layer, which softly combines the two images.