



Stargazer

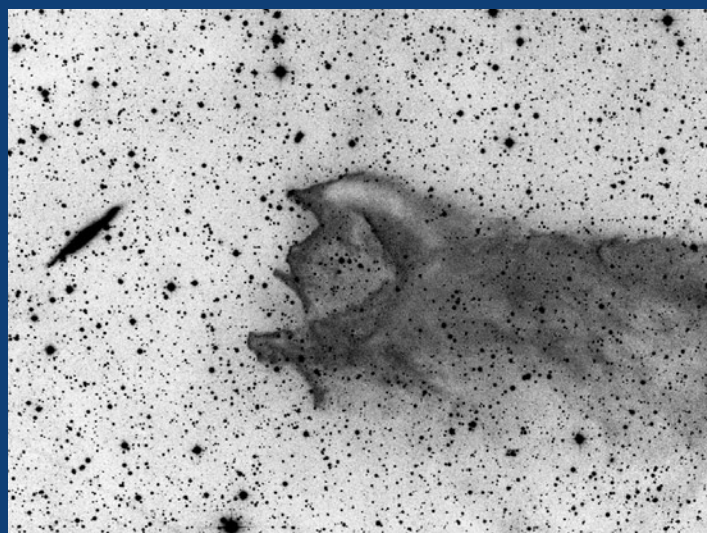
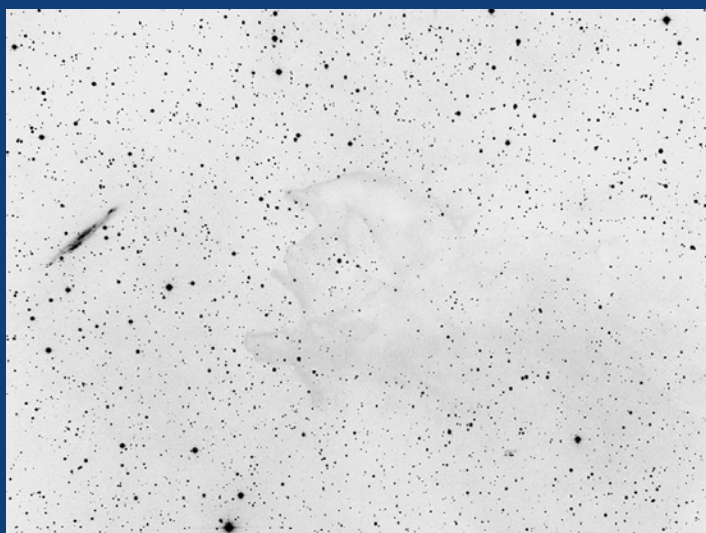
World-renowned astrophotographer brings objects in the universe to light using Adobe® Photoshop® CS2 software



When you see an exquisite color photograph of a galaxy or nebula, you have astrophotographer David Malin to thank. He developed the first practical method for making true-color astronomical photographs from black-and-white plates—a breakthrough because normal color film can't be used for astrophotographic purposes. Film does not work well with the long exposures required to capture the faint light of distant objects, so emulsions and glass plates must be used. Malin also developed imaging techniques capable of revealing faint details previously unseen by astronomers, leading to the discovery of new galaxies and other faint objects, as well as better color photographs.

By developing new methods of detecting faint objects, Malin has not only brought color and clarity to astronomy but also contributed to our current understanding of both the dimensions and distribution of galaxies, and the nature of star-forming nebulae and clusters of stars. Although his innovative techniques were initially developed in the darkroom, today Malin works his imaging magic using Adobe Photoshop CS2 software.

Before he began using Adobe Photoshop in 1993, Malin enhanced astronomical images in the darkroom. Below left: This image, taken in 1990, is an original photographic negative of a distant, dusty cloud feebly reflecting starlight. Below right is the same image photographically enhanced in the darkroom to show faint detail. A similar result can be obtained using the levels or curves controls in Photoshop.



From darkroom to digital

“Since the advent of Photoshop, most of the photographic methods I devised have digital counterparts,” says Malin. “Today, film-based processes in astrophotography have been almost entirely replaced by digital methods of image capture and processing, most using Adobe Photoshop CS2 at some stage. The result is that images can be processed far faster and with greater precision, improving our ability to understand the universe and to share its beauty.”

Malin worked for 26 years as a photographic scientist and astronomer at the Anglo-Australian Observatory (AAO). Although he’s officially retired, he still works in conjunction with the AAO, colorizing, retouching, presenting on the web, and giving new life to the vast set of photographic images that the observatory’s telescopes have captured since the 1970s. Though photography has long been supplanted by digital imaging at all professional observatories, the images made on glass plates cover a wide field of view and are still a valuable archive. The images from AAO

were captured using specialized black-and-white emulsions coated on glass. Equally specialized techniques are needed to extract information from these images and to combine them, bringing out unexpected color and faint detail.

In the past, these techniques required many hours in the darkroom. For instance, to create the first true-color astronomical photographs, Malin combined three images manually. He made positive black-and-white film copies of the monochrome glass negatives taken on large astronomical telescopes in red, green, and blue light. He then combined the three resulting images in register, using an enlarger and color filters to make true-color pictures of stars, galaxies, and nebulae. This is done much better and more effectively now using Photoshop CS2.

Malin’s were the first astronomical pictures of this kind made using additive and other enhancement techniques he developed. The processes he used and the resulting images stunned the world and were soon widely published on the covers of hundreds of books and magazines, including *Life* and *National Geographic*, and as a series of Australian postage stamps. The images have also appeared in international solo art exhibitions around the world and continue to be widely published.

Color: vital for understanding the universe

Before Malin, no one had devised a reliable method of color photography for astronomy based on the special black-and-white plates that were then widely used. His innovation was an important step not only for the general public but also for researchers, because color

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Malin created this three-color image in the darkroom by laboriously aligning separate, photographically enhanced black-and-white positives taken in red, green, and blue light under the enlarger. The color image was made using an analog version of the additive (RGB) process. Today, Photoshop CS2 makes this kind of image alignment quick and easy.



is crucial to understanding the universe, yet humans can't see it, even with a large telescope. In the visible part of the spectrum, a change in the proportions of light at different wavelengths is seen as a change in color, and color brings with it extra information that monochrome cannot. For instance, color can reveal relationships between parts of an object or changes in composition, temperature, or dustiness. Most of these relationships had been discovered before color photography but only after decades of painstakingly examining monochrome plates. Today, many astronomical observations are made simply to measure the colors of distant objects. In some cases, the objects are so faint that measuring color is almost all astronomers can do, because there is not enough light available to examine the spectrum in detail.

According to Malin, today it is far simpler to combine red, green, and blue images as separate RGB channels using Adobe Photoshop CS2 than it ever was in the darkroom. Almost all astronomical color pictures are made this way now, using data obtained digitally. However, Malin scans the large format positive contact copies he made from plates and combines them digitally into color images.

“With layers in Photoshop CS2 and ever more sophisticated ways of manipulating color channels, I have replaced the darkroom techniques that had served me well for 20 years with digital methods,” says Malin. “Now, in 2006, I do not have access to a darkroom. I do all of my image processing using Adobe Photoshop CS2, and the quality of my three-color images has never been better.”

Revealing minute details

In addition to showing the world the colors of the universe, Malin invented several new ways of revealing information on astronomical plates, a specialty that has given him an international reputation. Essentially, Malin used clever unsharp masking and copying techniques in the darkroom to reveal structure and detail that was there in the original plates but didn't show on film. Astronomers and astrophotographers have dubbed these techniques “Malinization.” Though they were devised for scientific purposes, they are also an integral part of his additive, three-color system.

To make an unsharp mask, Malin first made a contact copy of the negative on a sheet of low-contrast film, but with the back side of the glass in contact with the film. If the light source was diffuse, the resulting positive would be unsharp—blurred—and Malin could control the amount of blurring by adding extra layers of glass. By varying the exposure and processing of the mask film, he could also control the density and contrast of the mask. Once processed and dried, the mask was placed in position on the back of the original plate and a contact copy was made in the normal emulsion-to-emulsion manner, using a diffuse light copier. The unsharp positive had the effect of canceling unsharp information in the negative and reducing its dynamic range, so the resulting positive appeared sharper and was much easier to print. Malin's technique is the analog counterpart of the unsharp masking process in Photoshop CS2 and offers many of the same controls.

Organization

David Malin Images

Sydney, Australia

www.aao.gov.au/images.html

www.davidmalin.com

Challenges

- Replace manual darkroom tasks with more-efficient digital methods
- Enhance faint details in astronomical images
- Efficiently create color versions of images
- Reveal the hidden beauty of nebulae, stars, and other objects in the universe
- Improve the quality and fidelity of astronomical images

Solution

Use unsharp masking, color channels, and other features in Adobe Photoshop CS2 to reveal color and detail in astronomical photographs

Benefits

- Improved science output from photographic data
- Better exploitation of photographic archives.
- Revealed details that help astronomers learn more about the universe
- Helped the world celebrate the beauty, color, and variety of objects in the universe
- Created color images more efficiently

Toolkit

- Adobe Photoshop CS2
- Apple Power Mac G4 computer running Mac OS X



The special photographic plates used in astronomy record faint detail and are processed for maximum contrast. Anything that is not faint produces very high photographic densities that defeat most scanners, even today. Making color pictures from these plates was a challenge, and images made directly from the plates were disappointing. Years ago, Malin used photographic unsharp masking techniques

in the darkroom to reveal a wealth of detail. Above left is a photograph Malin produced in 1979, long before Photoshop appeared; above right is the same photograph, which Malin enhanced using Photoshop.



When Malin first started using them, these novel image enhancement techniques quickly led to the discovery of two new kinds of galaxies: Malin-Carter shell galaxies, with low contrast but large-scale features; and an extremely faint, uniquely massive proto-galaxy that has since been named Malin-1. These are some of the faintest objects ever detected by a ground-based telescope, and their discovery is the result of Malin's photographic processes. Malinization represented a significant advance in photographic astronomy, as well as being a major contribution to research on galaxies. The techniques led to other discoveries connected with supernovae, star formation, and galaxy interactions.

Bringing images to light

Today, instead of using Malinization techniques in the darkroom, Malin uses the Photoshop equivalent of his contrast enhancement techniques to extract otherwise unseen detail from long exposures. He selects a small section of the levels histogram in Photoshop CS2, perhaps 10% of the 255 digital levels available. All highlight detail is lost and minute variations in photographic density corresponding to faint astronomical objects are revealed, together with enhanced photographic grain noise.

Malin then uses the layers transparency control and the transform and rotate options to align many images from different plates. This process reduces the

noise, which varies from plate to plate, while at the same time enhancing the faint astronomical detail, which is the same on every plate. He uses Transform controls to precisely rotate and align similar photos while maintaining correct scale and the healing brush to remove dust and other blemishes, being careful not to remove entire stars or galaxies in the process. Malin also uses the gradient tools and masks to correct color in images that are non-uniform.

"Especially useful in Adobe Photoshop CS2 are the skew and distort possibilities for precisely aligning images that had unavoidable distortions from chromatic or other optical aberrations," says Malin. "This was always difficult and sometimes impossible in the darkroom, but it's easily accomplished using Photoshop CS2."

As a world-renowned imaging master, Malin finds it rewarding that many of the manual techniques and tools he developed in the 1970s are echoed in Photoshop CS2 in digital form. The software's powerful tools continue to enable him to produce and showcase some of the world's most beautiful and information-rich astrophotography. Thanks to the speed and efficiency of processing images using Photoshop CS2, Malin is more prolific than ever, adding to our knowledge of the universe and helping the world celebrate the beauty of the night sky.

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