

Preparing Colorful Astronomical Images III

Cosmetic Cleaning

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Introduction

A successful image keeps the viewer's mind focused on the content of the image, not on how it was created. We present cosmetic cleaning techniques for use with mainstream graphics software (Adobe Photoshop) to produce presentation-quality images and illustrations from astronomical data. These

techniques have been used on numerous images from the Hubble Space Telescope when producing photographic, print and web-based products for news, education and public presentation as well as illustrations for technical publication.

Common Pixel Artifacts

- Hot pixels
- CCD charge bleed (blooming)
- Residual cosmic rays, satellite trails
- Optical ghosts
- Bad columns or pixels
- CCD chip seams/gaps
- Coronagraphic holes, occulting masks
- Gaps, missing corners, etc.

Treatment of Pixel Artifacts

Several tools in Photoshop are particularly useful for fixing undesirable pixels in a digital or scanned image:

Clone Stamp tool (also available in The GIMP and older versions of Photoshop)

- copies pixels from a preselected sample region
- allows for varying brush size, hardness and opacity

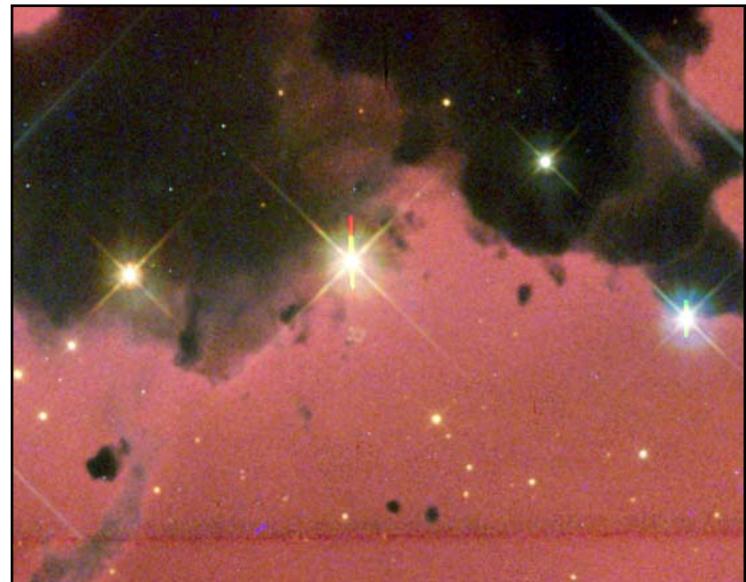
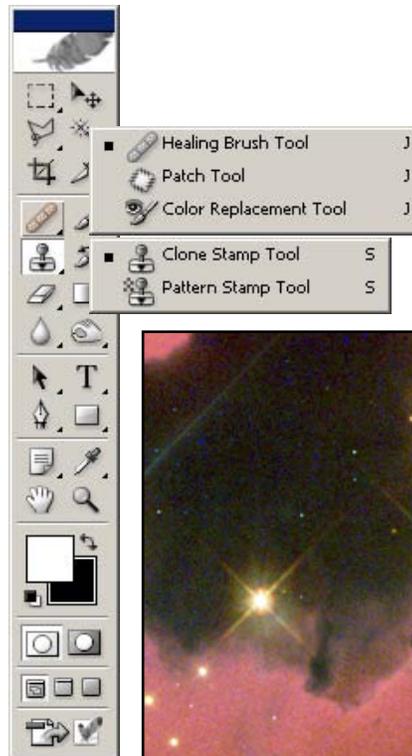
Healing Brush tool (Introduced in Photoshop 7.0)

- copies pixels from a preselected sample region
- allows for varying brush size, hardness and opacity
- matches the texture, lighting, and shading of the sampled pixels

Patch tool (Introduced in Photoshop 7.0)

- blends pixels like the healing brush tool
- repairs a larger area with pixels from another area

Recommendation: for smoother-looking results, apply many short strokes rather than fewer long continuous strokes and continuously redefine the source point.

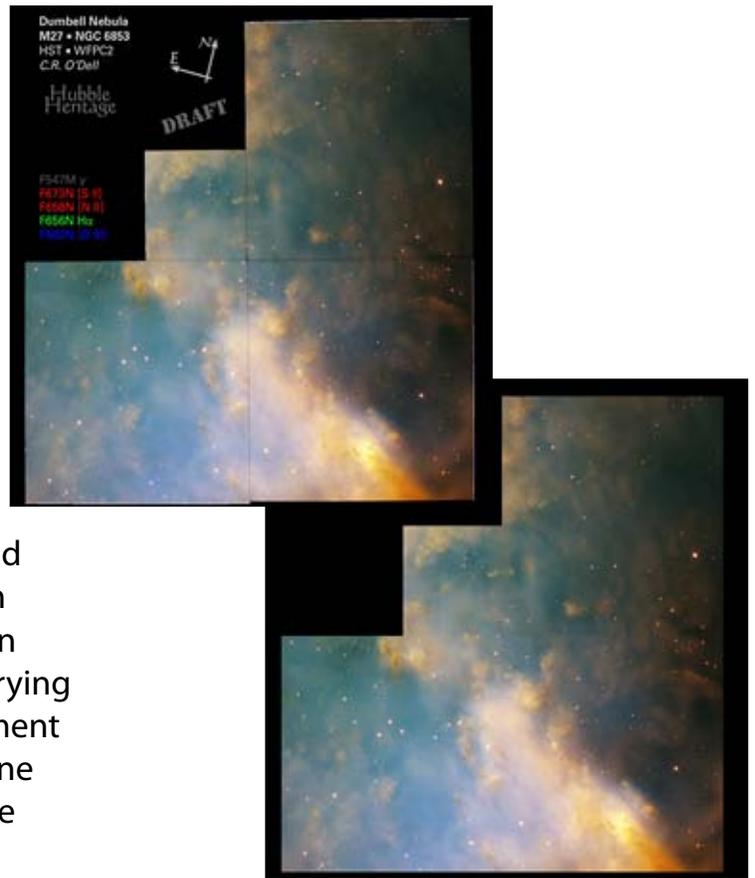


Mosaic Seams and Gaps

Many large format CCDs are a composite of individual chips that are mosaiced or stitched together to form the largest field of view possible. Some telescope detectors may even have a gap of pixels (e.g., Hubble Advanced Camera for Surveys) between chips. The resultant artifact will be a seam or gap on the image at the boundary of the CCD chips.

Treatment of Seams and Gaps

The clone stamp and healing brush tools are recommended to repair chip seams and gaps. For a chip seam where data exists on both sides of the seam, the **Clone Stamp** in **Normal**, **Darken** or **Lighten** mode with varying levels of opacity is recommended. Experiment with blending a 50% opacity clone from one side of a seam with a similar clone from the other side for a closer match.

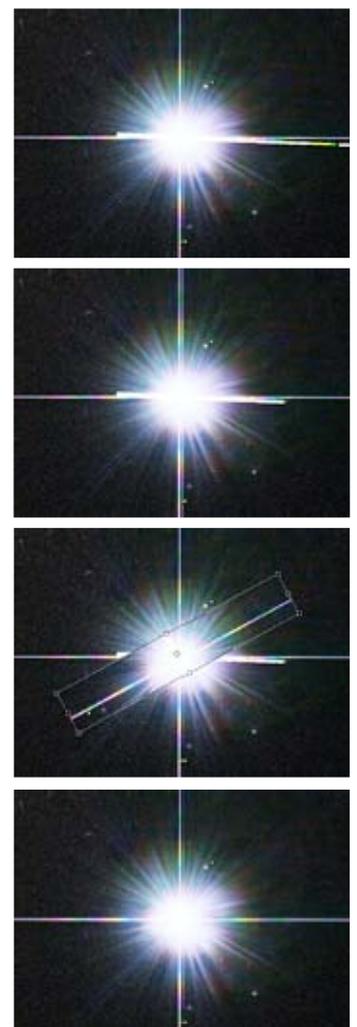
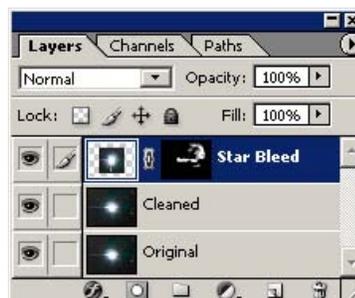


CCD Charge Bleeds

A common problem for optical images is CCD charge bleeds (i.e., blooming) from bright stars in the field. In contrast to normally symmetric and subtler diffraction spikes from the secondary mirror supports, usually left in an image for aesthetic reasons, the single-dimension bleeds are a distraction and should be removed. Bleeds are relatively simple to remove (with clone tools, for example) when they appear in a direction diagonal to diffraction spikes.

Bleeds that overlap diffraction spikes can be more difficult to remove. One can take advantage of the symmetry of the diffraction spikes:

- Copy a small section of the image containing the untainted diffraction spike pair into a new layer.
- Rotate the copy 90 degrees, aligning it with the bleed-affected diffraction spike pair.
- Erase or mask parts of the copy not needed to replace the bleed.
- Blend the edges using clone tools.



Noise Treatment

Some data may suffer from poor signal to noise. In Photoshop, there are several filters available which are effective at reducing noise and removing residual cosmic rays when a treatment by hand (such as with the **Clone Stamp** tool) is not possible:

Blur Filters:

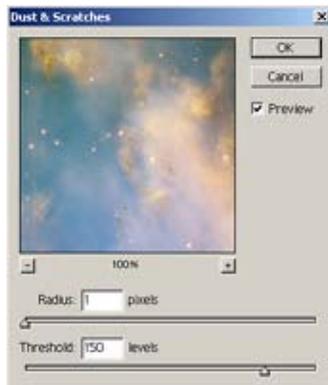
- **Blur** – no options available, use **Edit > Fade** to modify after application
- **Gaussian Blur** – blur radius adjustable to vary effect

Noise Filters:

- **Despeckle** – no options but use **Fade** to vary effect
- **Dust and Scratches** – interactive (can be subtle)
- **Median** – interactive (quite robust), particularly effective on very localized, bright noise (residual cosmic rays, which occur preferentially in a single layer/channel and thus appear as highly saturated color which is easy to isolate).

All of these filters smooth the image and therefore effect the overall resolution but can be minimized:

- Use the lowest level of the filter (smallest radius, etc.) which produces the intended result
- Apply the filters to a selected area only (using techniques described in background mismatch)
- Apply the filter to only the noisiest layer or channel.

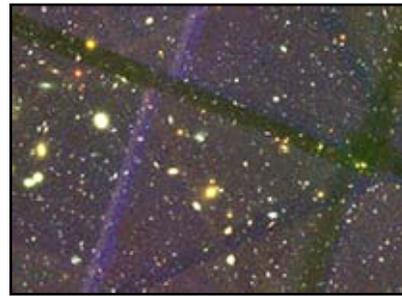


Sky Background Mismatch

Mosaics of multiple detectors and/or multiple pointings may result in a mismatch in the signal of the sky background, especially if no sky subtraction was applied during data analysis methods.

Treatments of Sky Background Mismatch

Carefully select the region to be treated with either a color or shape selection. Color selections can be made with the **Magic Wand** tool or **Select > Color Range**. Feathering (smoothing) the selection region is recommended to avoid obvious edges. Apply a **Curves** or **Hue/Saturation** change to match adjacent areas, hiding the selection boundary for a less cluttered view. If the effects are particular to an individual layer, consider working in that layer before flattening the image. Multiple smaller adjustments can be used to refine the overall appearance (remove a colorcast in one region, brighten another region, etc., with separate adjustments).



Recommendations:

- It is important to note that these techniques are intended only to be used to fix cosmetic defects in the image due to instrumental effects. Care must be used not to introduce artifacts or remove intrinsic structure from the image.
- Any cleaning should be done on a duplicate layer of the desired, flat image. This layer can then be blinked on and off to compare the cosmetically corrected image to the original.
- **Adjustment Layers** are recommended to permit unlimited refinement of the effects and to allow copying of the adjustment to a different image.
- Multiple adjustment layers serve as a simple means of documenting the procedural steps that were followed. These layers may be copied to other images for similar results.
- Uneven background, etc., can be exaggerated to make it easier to see while editing the image by applying a Levels adjustment that greatly increases the brightness and contrast. An **Adjustment Layer** is particularly useful to momentarily toggle the effect.