Color Balancing

Advanced Imaging Conference

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Color: Truth or Fiction?

- Color is based on the spectrum
- The spectrum is nearly continuous – there are millions of colors out there
- We use **three** color filters

- It is impossible to accurately represent colors with just three filters
- But…
The Eye as Detector

• The eye uses three sensors for color:
  – One for red
  – One for green
  – One for blue

• Eyes – three colors. CCD imaging – three colors. Is this enough to get True Color?

• The eye is just as limited as a CCD detector when it comes to color accuracy.
There is often more color available than you expect...
The Truth about Color

• The color you record with a CCD camera is only an approximation of True Color.
• The color you see with your eyes doesn’t necessarily match the color that another person sees.
• The color your monitor displays is random unless you use a tool to calibrate it to achieve accurate color.

• Ultimately, color is in the eye of the beholder.
The Dimensions of Color

- Color bias
- Color balance
- Color noise
- Color intensity (saturation)
Color Bias

• Color bias exists when one or more colors flood the background.
• The cause of color bias is unequal black points in the color channels.
Example of Color Bias

- Bias affects entire image, very visible in background.
- Like a false bottom in a container.
- Image at right:
  - Way too much green
  - Too much blue
Color Bias: Histogram Reveals All

- Multiple peaks in combined histogram
- Different black points in each color channel
- Lower black point results in stronger bias for that color
Color Balance

- Always adjust color bias first, then color balance
- Learn to distinguish color bias problems from color balance problems
- Color imbalance occurs whenever a color is stronger or weaker than the other colors.
- Like a container that is too full.
Color Imbalance Occurs When...

- Exposure times for color channels are not correct*
- Number of exposures for color channels are not correct
- Color bias is incorrectly treated as a color balance problem

* Filter wheel and camera manufacturers can supply color exposure ratios, or see Don Goldman’s web site:

http://www.astrodon.com/ColorExposure.html

To calculate your own color exposure ratios, see a web page on using the solar analog (G2V star) method:

http://www.ghg.net/akelly/artdraf7.htm
Recognizing Color Imbalance

- If the background is neutral, and the color of objects is out of balance, you have a color balance problem.

- Always correct color bias first so that background is neutral.
Color Balance via Structure

- It helps to know the color of objects and structures. Examples:
  - HII regions (strong ha-alpha emitters) are red (but frequently with a tinge or area of blue)
  - Galaxy cores are usually red
  - Starbirth regions where hydrogen gas of birth has been blown away are dramatically blue
  - Reflection nebulosity is typically blue
  - Emission nebulosity is dominated by red, but includes other colors based on the makeup of the emitting gas.
Color Balance via Histogram

• White point normally determines balance
• Because of stars, white point harder to use for color balance in astro images
• Pseudo white point an easier, more direct method for evaluating color balance
Color Balancing Tips

• The Color Balance tool can create a color bias. Be prepared to correct the bias, and then re-evaluate color balance.

• Best approach is to take color exposures of the correct duration for your CCD chip and color filters.

• Increasing a color’s presence to balance it may reveal the noise in that channel. Longer exposures (lower noise) permits a greater latitude in balancing color. Large color imbalances may require sacrificing dim data to make the color correction.
Pause for pretty picture... M98
Color Noise

- The noise level in each color should be approximately the same
- If one color is noisier than the other two, that color will appear weaker.

- Example: Light pollution is often strongest in green. This contributes extra shot noise to the green channel, increasing total noise in green.
Color Noise Examples

Smoothing reduces the contrast between colors...

...which reduces color saturation.

1 RGB set color smoothed

3 RGB sets color smoothed
What Is Noise?

• Noise isn’t a thing in the intuitive sense.
• Noise is uncertainty
• Uncertainty means random variations in brightness level.
• High noise = large variations = weak color
LRGB Exposure Times

- Assumes L images unbinned, color 2x2
- Total exposure time expands the portions of the image with color
- Adequate: bright objects have color
- Good: dim objects have trace of color
- Rich: all objects have low-noise color

- Adequate color:
  L = 4 x 10min 1x1
  R = 1 x 10min 2x2
- Good color:
  L = 4 x 10min 1x1
  R = 2 x 10min 2x2
- Rich color:
  L = 4 x 10min 1x1
  R = 4 x 10min 2x2
Color Intensity (Saturation)

- Increased saturation is more pleasing to the eye – up to a point.
- Noise in the color data limits how much you can increase saturation.
- Longer total exposure time lowers noise.
- Low noise = large increase in saturation possible.
Saturation Isn’t Reality

- Most non-emission objects are actually quite pale – consider how pale the color of stars is to the eye.
- Saturation is both a scientific and aesthetic consideration.
  - Saturation allows you to show more physical detail in an object.
  - Saturation pleases the eye.
Color Balancing Emission Nebulae

• Many 3-color filter sets do not capture emission nebulae colors in a balanced way (OIII split between blue and green)
• Balancing emission colors with appropriate exposure times will create imbalance in star and galaxy colors
• Solutions:
  – Use filter sets balanced for both, OR
  – Expose for stars, use layers in Photoshop to adjust color of emission nebula in a separate layer