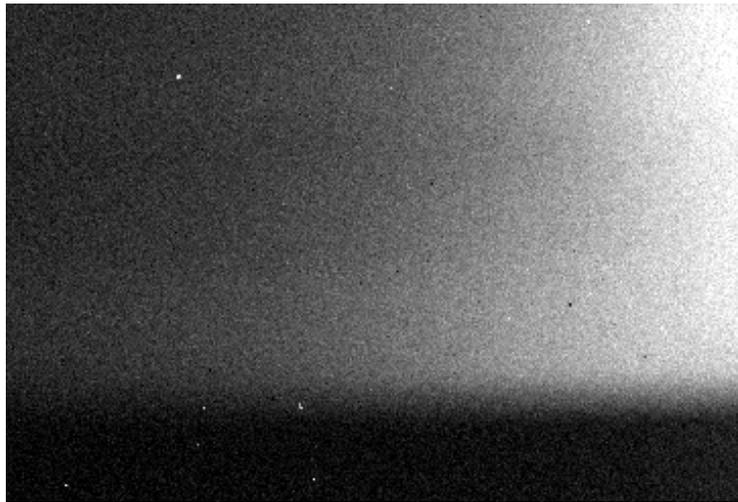


Mysterious Glow When Using Filter Wheel with ST-7/8/9/10 Cameras
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It has been reported to SBIG for some time that images taken with our camera sometimes show a mysterious glow when a filter wheel is used, but not repeatably. Some users have speculated that this is due to the filter wheel opto-sensor being stuck on. In past investigations we have determined that this theory is not the case. We have finally identified what is going on, and have developed a fix.

The Problem

Figure One shows a light image taken in dark conditions immediately after exercising a filter wheel 4 times. A dark taken before the filter wheel was exercised has been subtracted from it. The glow has a magnitude of about 120 counts in this ST-10XME image binned 3x3. The exposure was one minute. The glow taken with a single filter move is about 30 counts in a binned image, or 4 counts in an unbinned image. The effect is not huge, but is measureable. It becomes an issue when a color filter set of LRGB images is taken, since binning is often used, and the sky background is small due to the color filter.



After considerable testing we have finally figured out what causes this. When the filter wheel is moving, an opto-sensor in the filter wheel is illuminating the pins or tabs on the filter wheel as they go by to sense the filter position. When the position in the filter wheel that is blank, i.e. unfilled by a filter cell, goes by, the LED in the opto-sensor can flood the shutter area of the CCD camera with 940 nm light. Some light leaks around the shutter, and reaches the CCD, since our shutter does not block oblique illumination well. We have discovered that when our CCD is cleared right before an exposure, about 0.4% of the charge in the CCD is not cleared out, but slowly comes out over the next five minutes. This residual charge is what is causing this effect, and was the most perplexing discovery.

When doing a RGB color sequence, the opening in the filter wheel passes the opto-sensor when moving from the green to the blue filter. This effect then corrupts the blue image, which of course is the one most likely to be underexposed with little background. The effect is also hard to detect unless one is binning, which is often used when doing LRGB imaging for the color exposures.

We were surprised to find the residual charge in the CCD. We have often encountered a problem with bright stars leaving spots in darks taken after a light, but it seemed intermittent. This has some observing implications. Never take long darks right after long lights, or even exposing the camera to room light with the shutter closed. Let the charge bleed out first. I have found that the time constant for the charge bleeding out is 30 seconds at a temperature of 10 degrees C, and 70 seconds at a temperature of 0 degrees C. Presumably it is even longer at colder temperatures. Flushing the CCD by taking multiple images in focus mode does nothing.

The Filter Wheel Solution

For color imaging, the solution is simple. One only needs to add an empty filter cell in the open position in the wheel. The cell blocks the direct path from opto-sensor to shutter, and the effect is at least 30 times smaller. A stopgap solution is to wait a few minutes after changing filter positions, but this is no good for long term operation. If you have images corrupted by this effect, I recommend capturing images of it the way I described earlier, heavily smoothing the data to reduce the noise, and subtracting a scaled version of it from your blue images. We are discussing the CCD effect with Kodak to see if there is a way to better clear this residual charge out of the device. Now that we understand this phenomena we will takes steps to improve our product.
