**DSLR Spectral response**

Astronomical photometry is simply the measurement of intensity in a specific part of the stellar spectrum. This is achieved by using filters that pass only a defined range of wavelengths through to the detector resulting in a defined spectral response for the particular photometric passband.

In order for different observers to compare results they need to use filters and detectors with the same spectral response. There will always be some difference between filters and detectors but astronomers use a technique called transformation to correct these (hopefully) small differences. We'll cover transformation in some detail later.

There are dozens of astronomical photometric filters covering the ultra violet, visible and infrared. Each designed to extract specific astrophysical information. The ones most relevant to us are the Johnson B and V filters and the Cousins R filter which are the most widely used ones in the part of the spectrum DSLR detectors are sensitive to.

However, DSLR's were not designed for photometry and their rgb filters are not well matched to the standard BVR filters. This means transformation requires much larger corrections, and some types of stars are not suitable for transformation at all. This is because their spectra contain strong emission or absorption lines that fall within the spectral response of, say, Johnson B filters but not in the spectral response of DSLR b filters.

Figure 1 shows standard photometric filter response curves at the top and DSLR rgb filter response curves at the bottom.

Wavelength of peak sensitivity of the DSLR g filter closely matches that of the Johnson V filter but has a narrower passband. DSLR r and b filter passbands are also narrower than the equivalent astronomical filters and their peak sensitivities are much closer together. So the overall DSLR spectral response is more compressed than standard BVR filters.

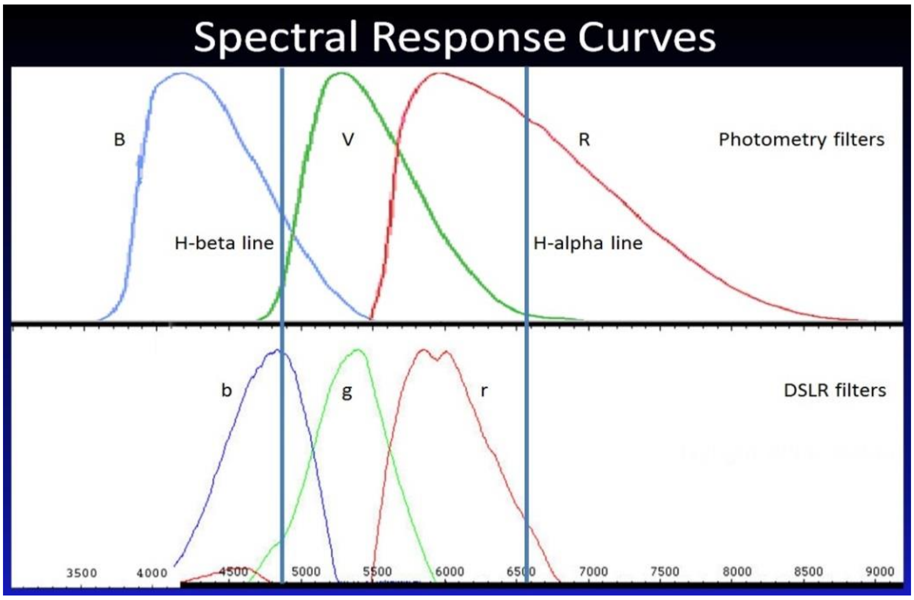


**Figure 1**

Also shown are the positions of hydrogen beta and hydrogen alpha lines which are prominent features in the spectra of some stars. Clearly an unmodified DSLR camera is much less sensitive to H-alpha than a Cousins R filter, but more sensitive to H-beta than a Johnson B filter.

Figure 2 shows a spectrum of V1369 Cen (nova Centauri 2013) with prominent emission lines including H-beta and H-alpha. Superimposed are the standard photometric filter response curves.

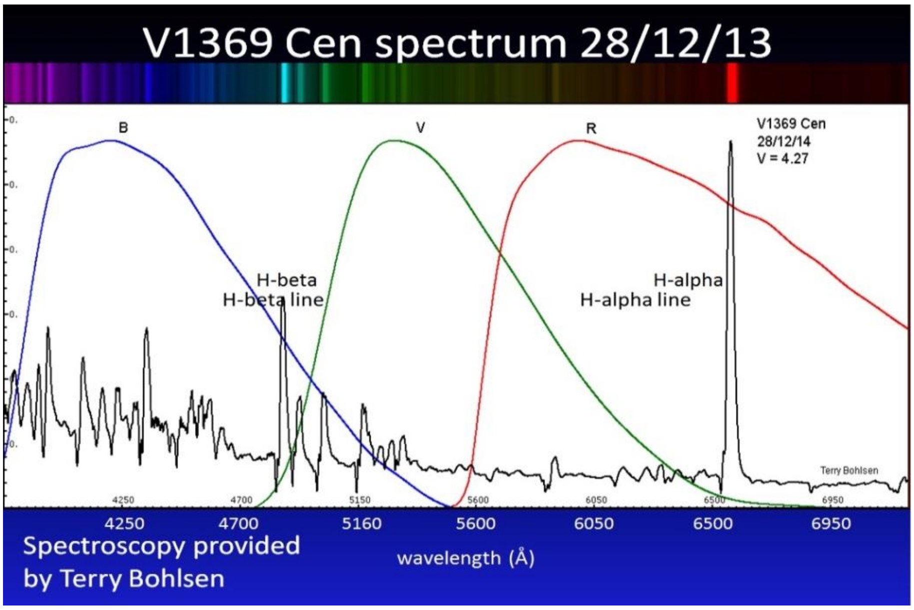


**Figure 2**

At this point in the nova's evolution my transformed DSLR R magnitudes were systematically lower by about 0.4 magnitudes than measurements made with CCD cameras with Cousins R filters. This was due to the intense H-alpha line.

On the other hand, my transformed DSLR B and V magnitudes were systematically too bright by about 0.2 and 0.1 magnitudes, respectively, due mostly to the H-beta line.

Figure 3 shows my transformed measurements (BMGA) compared with those made using the AAVSO's Bright Star Monitor South telescope (HQA).

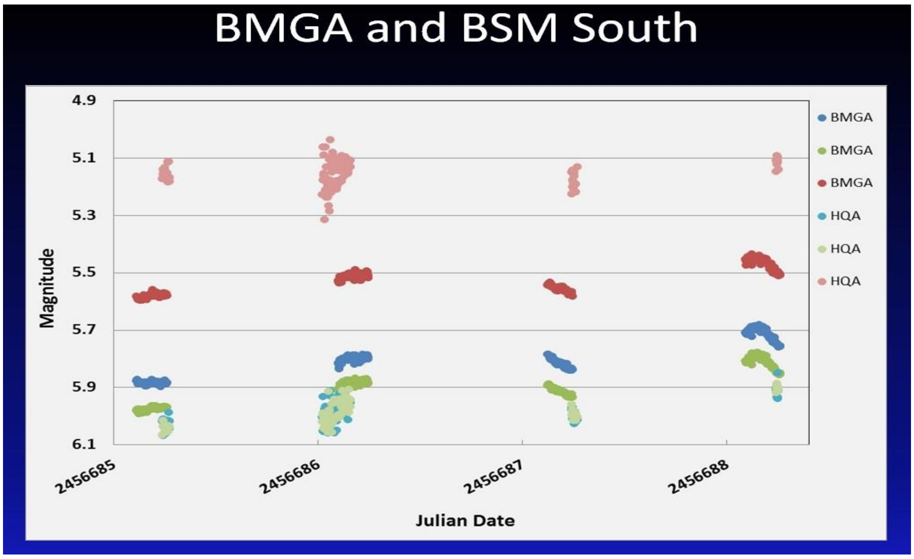


**Figure 3**

This is a very clear illustration of why DSLR instrumental magnitudes of certain types of stars (those with strong emission or absorption features) cannot and should not be transformed. By all means observe them but report the non-transformed magnitudes only.

Many types of stars have spectra with more subdued spectral features and the overall spectrum shape is approximately blackbody-like. DSLR instrumental magnitudes from these stars can be very successfully transformed to the standard Johnson-Cousins photometric system.

Table 1 lists transformed BVR magnitudes of 15 photometric standard stars measured with a DSLR. The average of 30 measurements is shown in the columns headed “ave” and the standard deviation of those measurements is shown in the “stdev” columns. Columns labelled “delta” list differences between my measured values and catalogue values.

As you can see, transformed DSLR V magnitudes are all within 0.02 magnitudes of the catalogue values and precision is below 10 millimag for all but the faintest stars. Accuracy and precision are only marginally poorer for B and R.

**Table 1.**

| | | B | | | V | | | R | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Star** | **ID** | **ave** | **stdev** | **delta** | **ave** | **stdev** | **delta** | **ave** | **stdev** | **delta** |
| E130 | HD 7706 | 7.763 | 0.011 | -0.021 | 6.569 | 0.007 | -0.011 | 5.939 | 0.010 | -0.027 |
| E142 | HD 10167 | 7.003 | 0.011 | 0.008 | 6.672 | 0.007 | 0.007 | 6.487 | 0.015 | 0.018 |
| E134 | HD 8001 | 8.254 | 0.012 | 0.005 | 6.767 | 0.006 | 0.001 | 5.984 | 0.011 | 0.012 |
| E121 | HD 9733 | 7.829 | 0.011 | 0.013 | 6.921 | 0.006 | 0.004 | 6.445 | 0.011 | 0.018 |
| E132 | HD 8963 | 8.456 | 0.012 | 0.001 | 6.955 | 0.006 | -0.006 | 6.175 | 0.012 | 0.003 |
| E131 | HD 10121 | 8.116 | 0.012 | -0.023 | 6.964 | 0.007 | -0.011 | 6.374 | 0.012 | -0.030 |
| E143 | HD 8391 | 7.353 | 0.010 | -0.006 | 7.023 | 0.007 | -0.001 | 6.837 | 0.015 | 0.006 |
| E104 | HD 8305 | 7.799 | 0.013 | -0.018 | 7.437 | 0.007 | -0.018 | 7.228 | 0.018 | -0.014 |
| E170 | HD 10101 | 8.609 | 0.016 | 0.008 | 7.576 | 0.009 | -0.003 | 7.049 | 0.017 | 0.004 |
| E101 | HD 8977 | 7.798 | 0.012 | 0.007 | 7.710 | 0.008 | 0.006 | 7.670 | 0.021 | 0.004 |
| E146 | HD 7795 | 7.764 | 0.012 | -0.007 | 7.849 | 0.009 | -0.008 | 7.887 | 0.024 | -0.012 |
| E122 | HD 7886 | 9.023 | 0.021 | 0.007 | 8.019 | 0.011 | 0.009 | 7.489 | 0.025 | 0.008 |
| E109 | HD 9403 | 8.727 | 0.022 | 0.022 | 8.206 | 0.011 | 0.019 | 7.913 | 0.034 | 0.017 |
| E173 | HD 9160 | 9.355 | 0.032 | 0.012 | 8.322 | 0.014 | 0.019 | 7.777 | 0.032 | 0.009 |
| E102 | HD 8382 | 8.659 | 0.029 | 0.009 | 8.449 | 0.020 | 0.005 | 8.335 | 0.051 | 0.017 |

So the take home message is that you need to be aware some stars are unsuitable for DSLR photometry if transformed magnitudes are required, but there are many types of stars that are suitable for transformed DSLR photometry. Even the pathological stars can be observed by DSLR if you report non-transformed magnitudes.