Video Astronomy Using LP + IR Block Filters
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Test Report – January 24, 2012

Objectives:
My objective for this test was to evaluate the impact of several different Light Pollution (LP) filters plus two different IR Block filters on the appearance of an emission nebula as viewed through an astro-video camera. Of specific interest to me was how the custom UV/IR block filter I had made by Omega Optical (Brattleboro, VT) performed compared to a commercially available UV/IR block filter, and to no UV/IR block filter at all. I have named the custom Omega filter the Blue & Deep Red Blocker (BDRB), it has an average response of better than 90%, and its FWHM is defined as a band 185nm wide centered on 580nm. The following filter combinations were tested:

1. no filters
2. Astronomik UHC alone
3. Astronomik UHC + Baader Planetarium UV/IR Cut
4. Astronomik UHC + Omega BDRB
5. Meade O-III alone
6. Meade O-III + Omega BDRB

The figures below present the spectral response curves of the various filters being used, as well as the appearance of the spectral response when the LP and IR cut filters are combined.

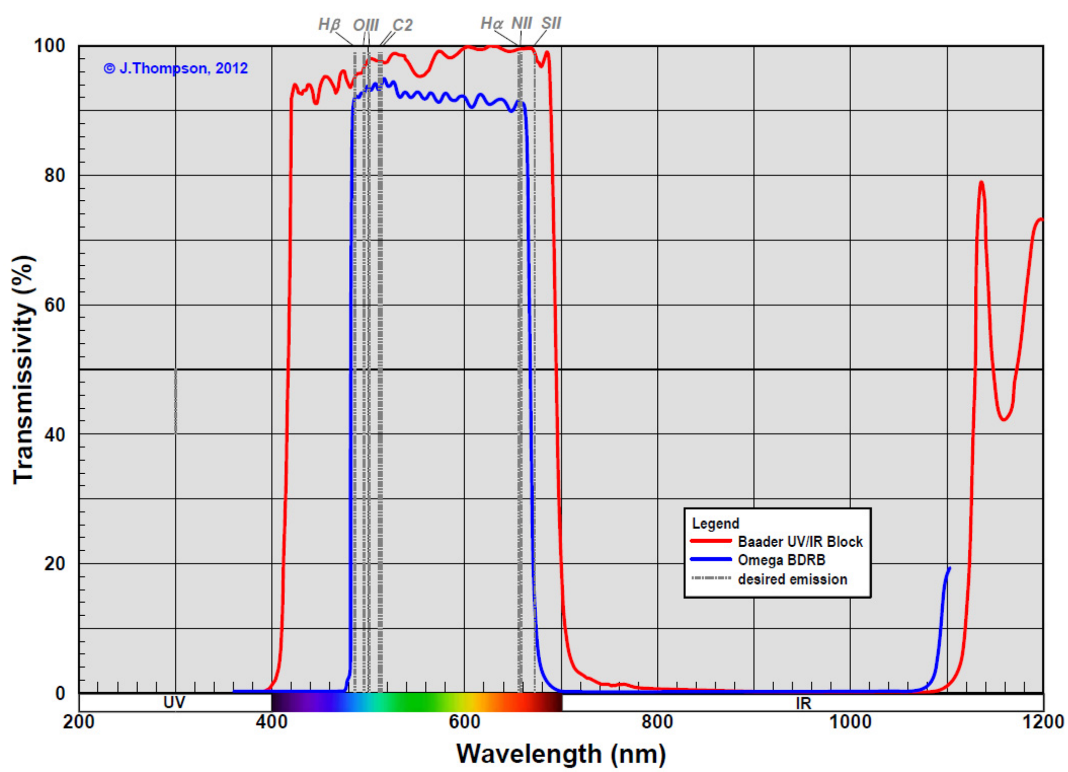

Figure 1 Spectral Response Curves - UV/IR Blocker Filters

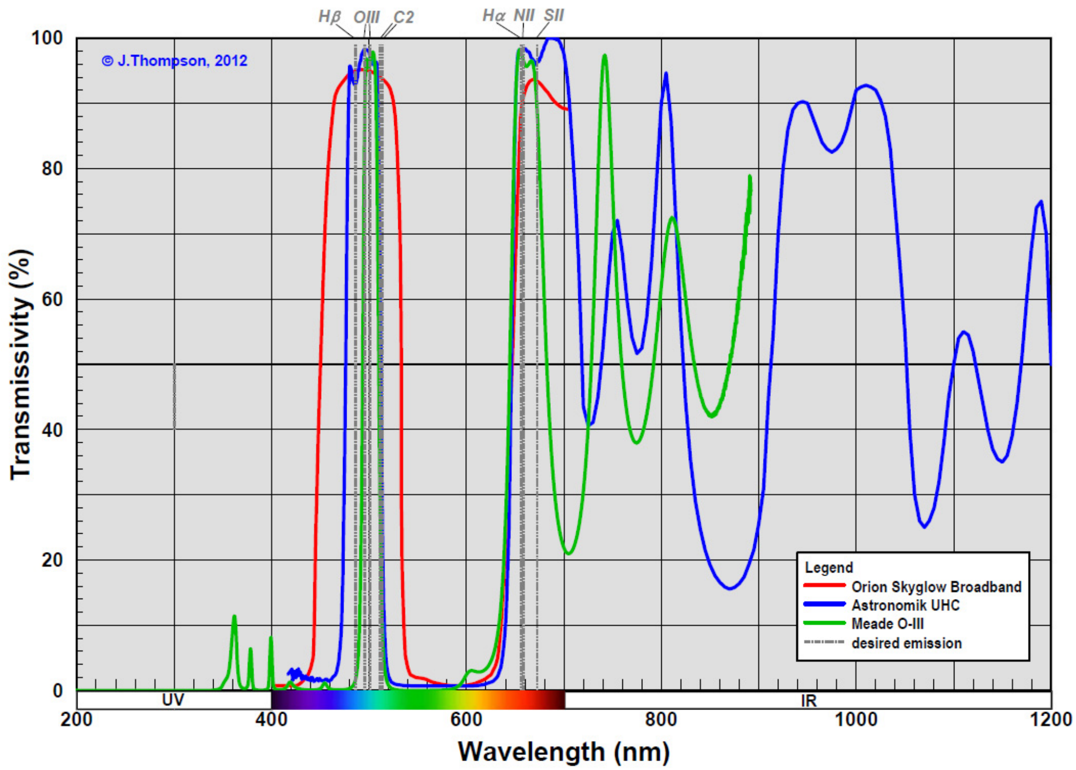

Figure 2 Spectral Response Curves - LP Filters

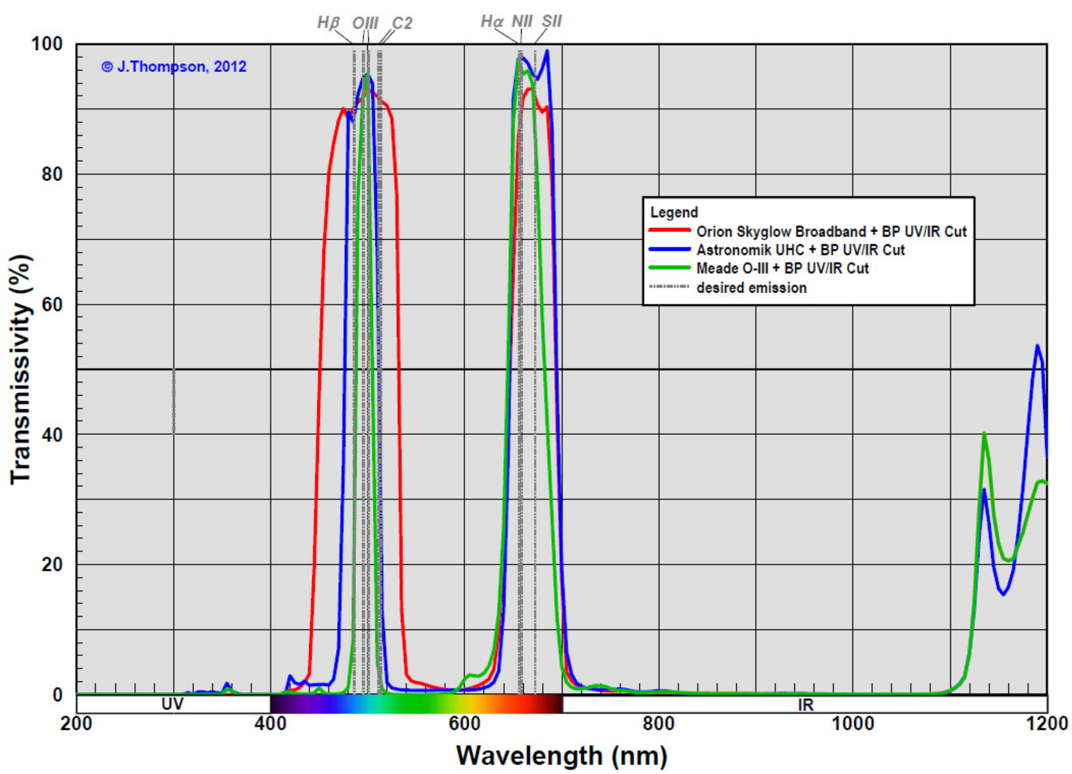

Figure 3 Spectral Response Curves - LP + Baader UV/IR Cut

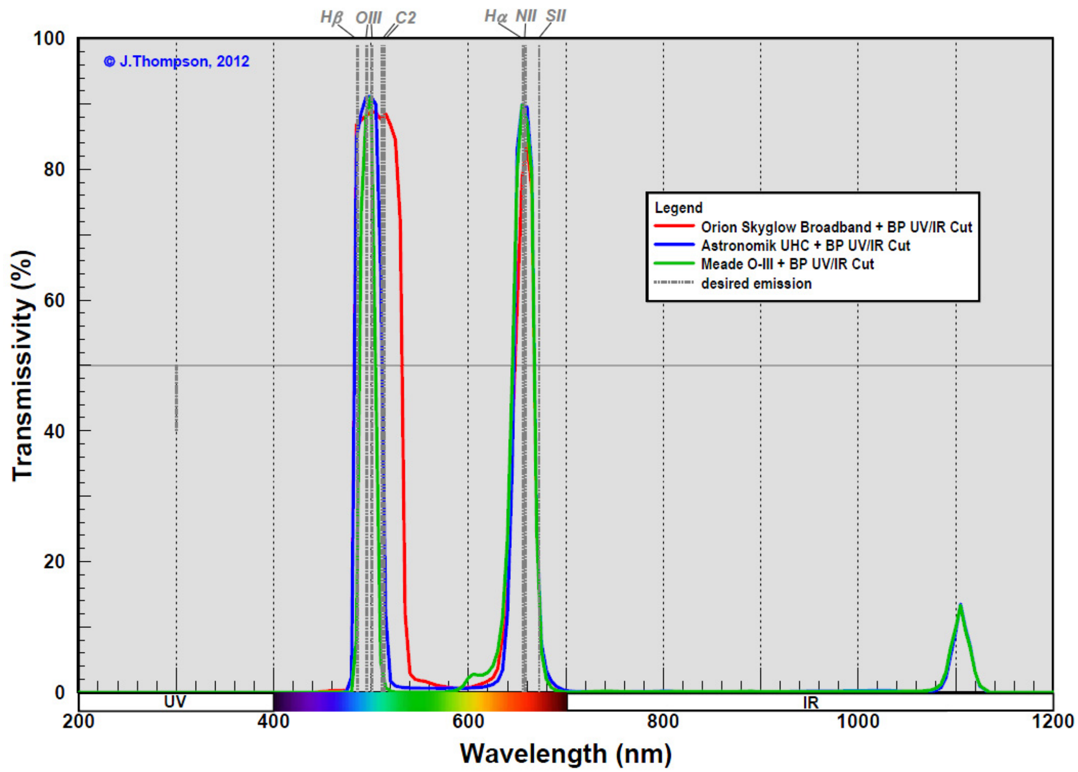

Figure 4 **Spectral Response Curves - LP + Omega BDRB**

Note that I have included the curve for the Orion Skyglow Broadband filter in the graphs above as a point of comparison to the other filters tested as it is a relatively common LP filter. Also it is important to note that the Meade O-III filter is unusual in that it has a good response to Halpha. All other O-III filters except the IDAS O-III have little or no response to Halpha.

Methodology:

I used a single deep-sky object as my target: M42 the Orion Nebula. I used my Meade 8" LX-10 SCT with the Meade f/6.3 focal reducer/field flattener (on SCT thread) plus the MFR5 focal reducer (on camera 'C' thread), giving me an overall focal ratio of approximately f/2.4. Some vignetting and star coma is detectable in my images as a result of this FR combination, but the FOV is favorable for M42. The telescope was mounted to my Orion Atlas mount, and remotely controlled through my laptop from inside the house.

I used my Mallincam Xtreme to capture all image data. The camera and capture device were running with the following settings:

- AGC 4
- gamma 1
- APC vert & horz 2
- white balance ATW
- contrast 65 (full)
- hue 62

- saturation 35
- sharpness 1
- TEC set to “off”, level 4 sensitivity, 10sec dew prevention

Brightness (BRT) and Integration time (INT) were adjusted throughout the testing, as will be described below. Each time I changed a filter combination I moved to either Sirius or Rigel and used a Bahtinov mask to refocus the telescope.

Results:
Testing was done from my backyard in Ottawa, Canada during below average conditions: 100% clear, poor to below-average transparency (2/5), and average seeing (3/5). The Moon was not in the sky for the duration of the testing, which was done over a two hour period from 9 to 11pm on January 21st, 2012. M42 was located in the SSE to SW, ranging in altitude from 33° to 39°.

All the images captured were done at a fixed set of INT times, stepping up from 2sec to whatever maximum INT gave a brightness setting of 0 and started to wash out the background. During my testing I found that as the INT times got above 40sec, the effect of mount tracking accuracy and the seeing conditions resulted in a progressive reduction in image sharpness. For the “no filter” case, the longest INT I could achieve was 8sec. The resulting image was very washed out with poor contrast and color intensity due to the light pollution. Adding the UHC filter (as well as the Meade O-III) had a dramatic affect on the quality of the image. Contrast was increased, the colour balance was better, and longer INT times were achievable allowing fainter details to be resolved. Adding the Baader UV/IR cut filter to the UHC resulted in an improvement in the quality of the image, somehow smoothing out the noisiness and increasing image contrast slightly. The intensity of stars in the field of view was also reduced by the IR cut filter. A slightly longer INT time was achieved with the IR cut filter added. Adding the Omega BDRB filter did much the same as the Baader UV/IR cut, except to a larger extent. The BDRB resulted in the smoothest looking images, with the darkest background and biggest reduction in star intensity. The increase in contrast resulting from the BDRB seems to be weighted more towards the red end of the spectrum, highlighting Halpha regions more than O-III regions.

To provide further confirmation of the impact of UV/IR cut filters on LP filter performance, I have used my analytical method to predict their performance. For more information on my analytical method, please refer to my magazine articles #5 and #6. The method gives a prediction of the RGB level from 0 to 255 for a given observation target relative to the background. A minimum of 5 is required for the target to be visible, at least with the telescope setup I assumed in my analysis: an 8” SCT at f/10 with camera effective focal length of 8mm. The results of my analysis are summarized in the table below, for a MAG+3 sky (heavy light pollution with no Moon). My analysis results are consistent with what I observed during my test, except for the fact that Halpha seems to be highlighted more than O-III during testing. This difference may be due to my using M27 (bright nebula) and NGC7000 (dim nebula) in my analysis, which have different emission spectra than M42.


No filter, INT 8sec, BRT 0


UHC, INT 8sec, BRT 82


UHC, INT 40sec, BRT 0


UHC+BP IR, INT 8sec, BRT 85


UHC+BP IR, INT 40sec, BRT 12


UHC+BDRB, INT 8sec, BRT 85


UHC+BDRB, INT 40sec, BRT 33


Meade O3, INT 8sec, BRT 85


Meade O3, INT 40sec, BRT 11


Meade O3+BDRB, INT 8sec, BRT 85


Meade O3+BDRB, INT 40sec, BRT 47

UHC+BP IR, INT 50sec, BRT 0

UHC+BDRB, INT 55sec, BRT 0

Meade O3+BDRB, INT 65sec, BRT 0

LP Filter	Bright (O-III Rich) Nebulae			Dim (Halpha) Nebulae		
	No IR Cut	BP IR	BDRB	No IR Cut	BP IR	BDRB
None	20.2			1.6		
Orion Skyglow Broadband	49.6	55.6 (+12%)	79.1 (+59%)	3.6	4.1 (+14%)	5.5 (+53%)
Astronomik UHC	72.7	87.5 (+20%)	111.8 (+54%)	5.4	6.6 (+22%)	8.1 (+50%)
Meade O-III	100.7	125.9 (+25%)	140.8 (+40%)	6.2	8.0 (+29%)	8.3 (+34%)

Table 1 Predicted Video Image RGB Level (0-255)

Conclusions:

1. As I have determined as well in past testing, using a LP filter can dramatically improve the quality of an astro-video camera's live image. The improvement comes at the cost of increased INT time.
2. Adding a UV/IR cut filter does improve the clarity and contrast of the image when viewing an emission type object. The improvement demonstrated during this test is almost entirely due to a reduction in light pollution. Further gains can be realized when using UV/IR cut filters with achromatic refractors due to the elimination of unfocused UV/IR light that blurs the image. A UV/IR cut filter will hurt the view of galaxies and possibly reflection nebulae, especially the Omega BDRB.
3. The Astronomik UHC and Meade O-III both performed similarly well, with perhaps an edge to the Meade O-III. Views with both LP filters were best with the BDRB added, resulting in images that were much smoother and with more contrast in Halpha regions. I do not understand why adding the IR cut filters resulted in a smoother (less noisy) image.
4. Adding a BDRB to a typical inexpensive LP filter like the Orion Skyglow Broadband can provide a substantial improvement in filter performance, when used for video astronomy or other CCD imaging activity.

If you have any questions, please feel free to contact me.

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