LP Filters Under Dark Skies
by Jim Thompson, P.Eng
Test Report – May 5th, 2013

Objectives:

Much work has been done by myself and others to show the benefits of using a commercially available light pollution filter (also called nebula filter) to improve the view achieved with an astro-video camera. As a result, many video astronomers are using LP filters with their cameras with great success. The effectiveness of LP filters at reducing light pollution is undeniable, but what if the observer is not under heavily light polluted skies? Is there any point to investing in an LP filter if you already have skies with a limiting magnitude (Mv) of +5 or better?

When I developed my analytical method for evaluating the performance of LP filters I included the case of a pristine sky in my calculations (Mv +7). I did not share the results of that analysis with anyone as I first wanted to confirm through observation what was being predicted. The basic gist of my analysis was that for galaxies or other broad spectrum targets (globular clusters, reflection nebulae, etc.) there is no advantage to using an LP filter when under dark skies. On emission nebula however, the contrast improvement under dark skies was predicted to be high, in some cases even higher than under light polluted skies. This test report presents the findings of my analytical method under dark skies, as well as my observations from this past summer where I tried to confirm if this prediction is true.

Methodology:

The methodology of this test is simple: look at the same object with the same telescope with and without a LP filter under dark skies. I collected observations from three different sessions:

1. July 13, 2012: shores of Ottawa River north of Petawawa, ON (Mv +5.0 to +5.5), Williams Optics Zenithstar 66mm ED refractor with FR (~f/3.7), filters C & E;
2. July 20, 2012: Rock Mallin's property in Foymount, ON (Mv +5.8 to +6.3), Canon 17-102mm zoom lens (~f/2.1), filters A to F; and
3. July 21, 2012: Rock Mallin's property in Foymount, ON (Mv +6.1 to +6.3), VRC8 with FR (~f/3), filters A, D, and E.

Sky magnitude for the first observing session above was estimated visually, but was measured with a sky quality meter during the second two sessions. A number of different LP filter combinations were used. The filters considered in my testing were:

A. no filter
B. Baader Planetarium UV/IR Cut
C. Astro Hutech IDAS LPS-P2
D. BP IR Cut + Astronomik UHC
E. Meade O3 + Omega Optical Blue-Deep-Red Blocker (BDRB)

F. Omega Optical H-alpha (red band pass machine vision filter XMV660)

All observations were made using my classic Mallincam Xtreme, all mounted from my Atlas EQ/G mount. All frames presented below are single frame captures, no stacking or other post processing.

The criteria for comparison was: is the object easier to see (higher contrast), and is the object more pleasing to observe.

Results:

Analytical:
A good way to start is to review what makes up the light we see in the sky. I generated Figure 1 below as part of my research for my analytical method. I needed to determine on average what the spectrum of objects we observe and the background skyglow is, and what their brightness is relative to each other.

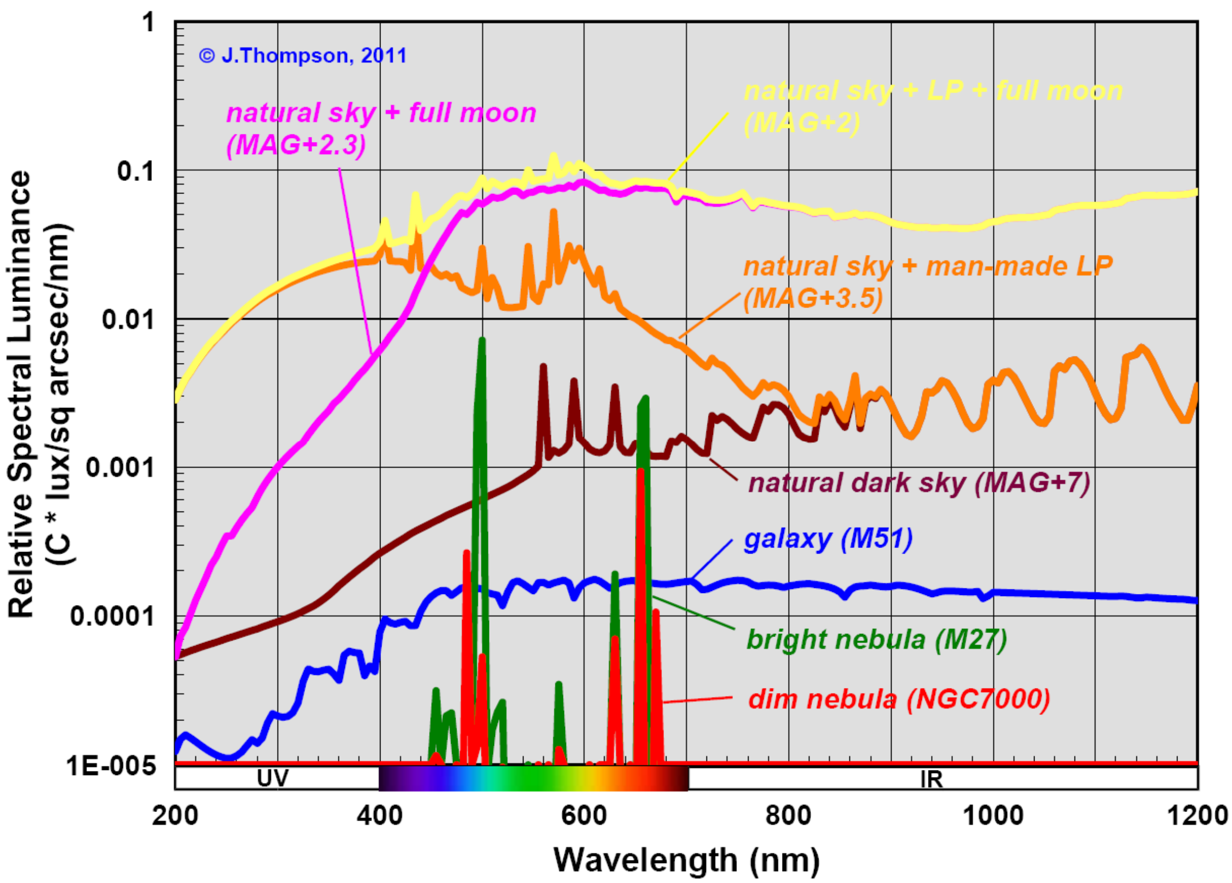


Figure 1 LP & DSO Emission Spectra in Absolute Scalar Units

A natural dark sky still has some light pollution, mostly from molecules in our upper atmosphere that are ionized by ultraviolet light from our Sun. These emissions show up as small spikes in the visual band (from Na and O ions), and as a repeating pattern of emission bands from OH ions in the infrared band. Man made light pollution is observed mostly in the visual band, which when you think about it makes sense! There are large spikes associated with the different types of lighting (low and high pressure sodium, mercury) as well as continuum emissions from halogen type (incandescent) light sources. Moon light is reflected sunlight with some self emission in the infrared band, making the Moon a broad spectrum light source adding to the light pollution at all wavelengths. Depending on the combination of these three sources, an LP filter will be more or less affective at improving the view.

One thing can be said for my analytical filter performance model: it sure can generate a lot of data. Often times the best we can hope for is to understand the trends of how things behave, without looking too closely at the actual numbers. The actual numbers from my analysis are pretty surprising. Table 1 below summarizes the predicted increase in RGB level for a few common LP filters under varying sky conditions, as calculated for an 8" SCT reduced to f/6.3. The RGB level is the average brightness of the deep sky object you would see on your screen from 0 to 255, where the background is totally black (RGB=0).

Filter	Bright O-III rich nebulae			Dim H-alpha rich nebulae			Galaxies		
	Mv +2.0	Mv +3.5	Mv +7.0	Mv +2.0	Mv +3.5	Mv +7.0	Mv +2.0	Mv +3.5	Mv +7.0
No Filter RGB Level	4.0	20.2	181.3	0.3	1.6	16.3	2.7	13.6	127.4
Baader UV/IR Cut	+33%	+19%	+62%	+32%	+20%	+79%	-9%	-18%	+21%
Lumicon Deepsky	+99%	+151%	+74%	+87%	+138%	+81%	+6%	+37%	+5%
IDAS LPS-P2	+108%	+92%	+140%	+97%	+81%	+183%	-6%	-12%	+35%
Astronomic UHC	+163%	+260%	+104%	+139%	+238%	+119%	+8%	+53%	+1%
Astronomic UHC + BP IR Cut	+287%	+321%	+247%	+255%	+299%	+404%	-3%	+10%	+39%
Orion H-alpha	+791%	+1183%	+344%	+3197%	+5258%	+2458%	-8%	+59%	+4%

Table 1 Predicted Contrast Improvements With Select LP Filters

There is a lot of information buried in Table 1, and some pretty ridiculous numbers too (+5258%!). At the very least there are some interesting observations that can be made from these predictions:

1. LP filters can greatly improve the contrast of an emission type nebulae under any sky condition;

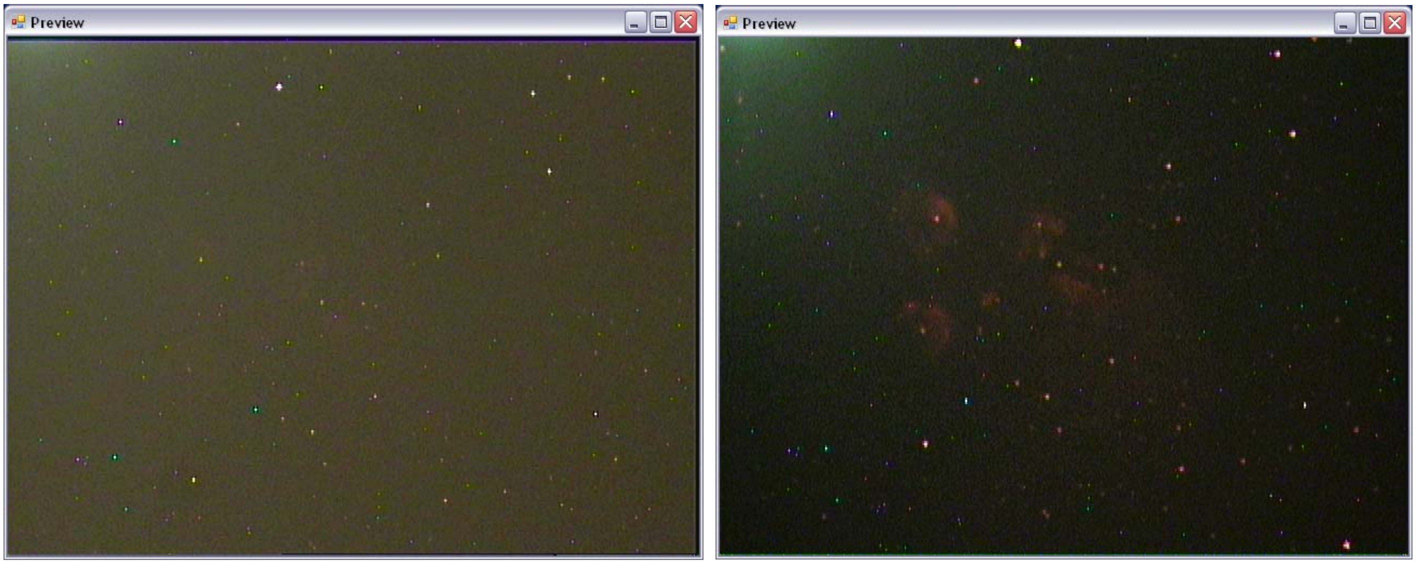
2. Some LP filters can improve the contrast of galaxies but the impact is small compared to what they can do for emission nebulae;
3. LP filters are not able to improve the contrast of a deep sky object more than what you would achieve by going to a darker location. The exception is using an H-alpha filter on emission type nebulae;
4. When observing emission type nebulae under light polluted skies, there is an advantage to adding an IR cut filter to your LP filter;
5. When observing galaxies under light polluted skies, the contrast is worse if you add an IR cut filter; and
6. When observing any deep sky object under dark skies, there appears to be an advantage to using an IR cut filter.

The observations that I find most interesting are #1 and #6. The statement that LP filters help the contrast of emission type nebulae under any sky type has been observed by myself in practice, some examples of which I present below. The statement that an IR cut filter helps any DSO under dark skies is a new idea to me that has come to light while writing this report. I have yet to test this theory out with observations.

Observations:

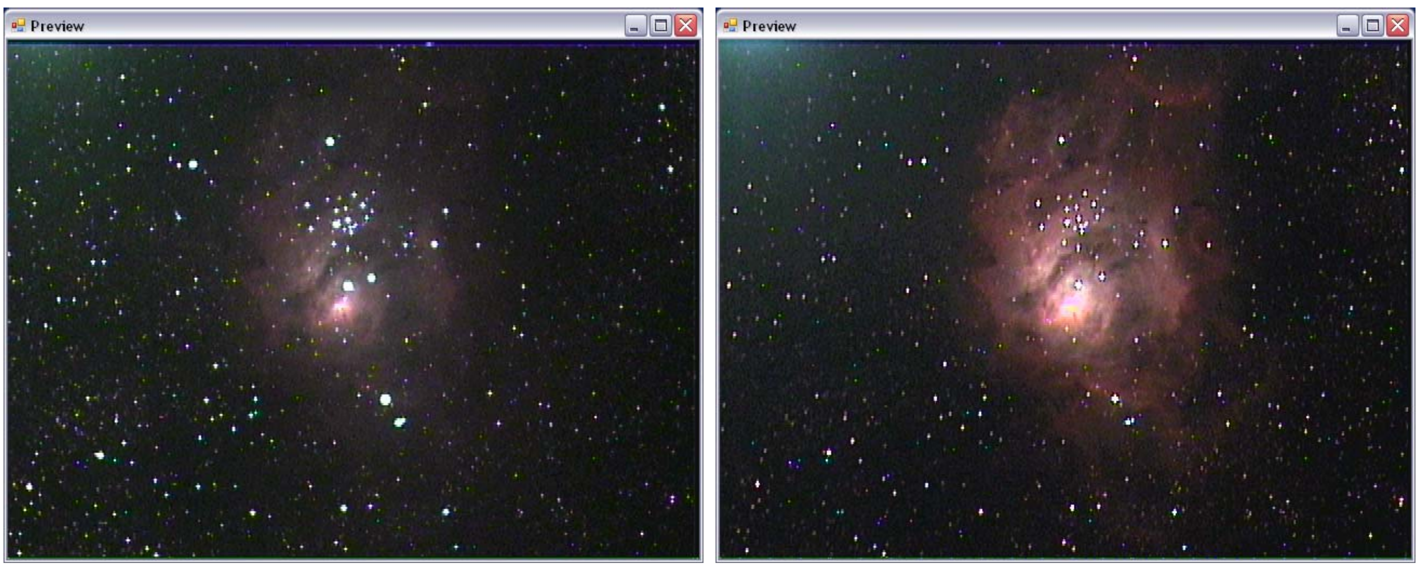
- July 13, 2012: shores of Ottawa River

This wasn't really meant to be an observational test, I was really just having fun observing at my in-laws' cottage on vacation. I noticed that on the previous night when I used a fairly narrow filter combination (Meade O-III + Omega BDRB) I was getting a better image than I was on this night with a wider filter (Astro Hutech IDAS LPS-P2). Out of curiosity I captured images of a couple of different objects using the two filter combinations. Since I was not in the mindset of a proper test, I did not record much information other than the object name and integration time (INT). I found the images to be strikingly different between the two different filter setups, way more apparent than I would have guessed. With the IDAS LPS-P2 installed, the longest INT I could use and still have BRT adjustment enough to darken the background was around 60sec. With the Meade O-III + BDRB filter combo I was able to go to at least 360sec, with even longer probably possible but I didn't try. Stars were also noticeably smaller/tighter with the narrower LP filter combo, making for a more pleasant image. I did notice that the ampglow is more noticeable in the images with the narrow LP filter. The reason for this being a higher BRT setting was needed to get a dark background, so the ampglow was less "turned down" than in the images with the LPS-P2 filter.



IDAS LPS-P2 (BRT=0) | Meade O-III + BDRB (BRT>0)

Figure 2 NGC6334 Cat's Paw Nebula, 60sec INT



IDAS LPS-P2 (BRT=0) | Meade O-III + BDRB (BRT>0)

Figure 3 M8 Lagoon Nebula, 60sec INT

IDAS LPS-P2 (BRT=0) Meade O-III + BDRB (BRT>0)

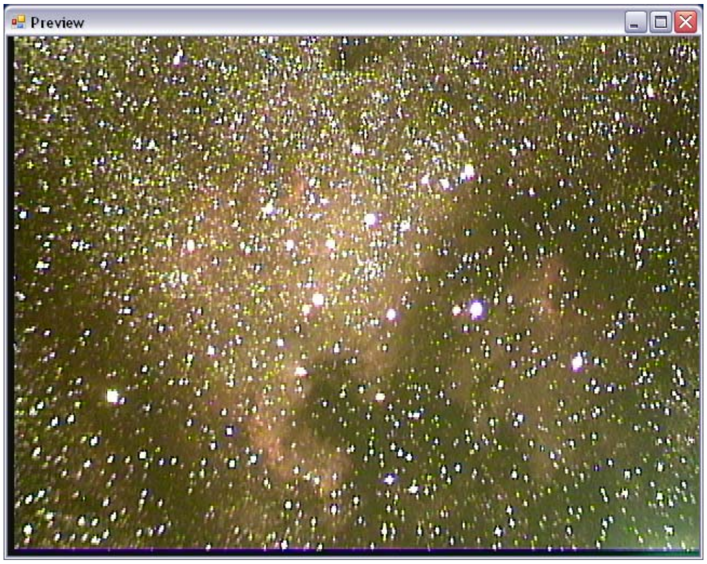
Figure 4 M20 Trifid Nebula, 60sec INT

- July 20, 2012: Foymount

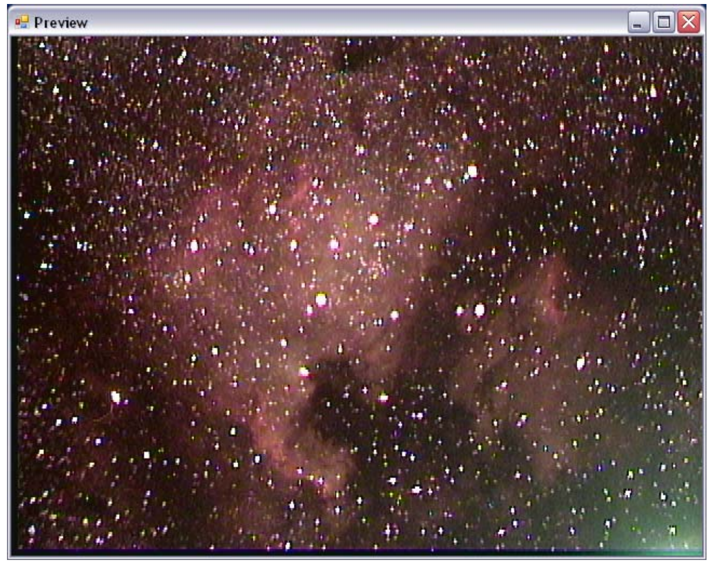
This time I fully intended to test out this idea of filters being affective under dark skies. Where better to do such a test than in Foymount, ON? I used my little Canon TV lens for this first batch of tests because it is very easy to change filters on it. The filters simply screw onto the front of the camera, making the process go very quickly and allowing several filters to be tested in a night. I recorded images in two different ways: with the same INT time but different BRT, and with different INT times but BRT the same at zero.

The two targets I chose to view are both located in an area of the sky with lots of stars. Both the North American Nebula (ngc7000) and Dragon Nebula (that's what I call it anyway, ic1318) are large nebulous regions located in the constellation Cygnus, which is aligned with the Milky Way. The presence of so many stars in the image tended to clutter the image and make it difficult to see the nebulosity. Application of LP filters reduced the brightness of the stars, and as a result made it easier to see the nebulosity, as can be clearly seen in the images below. Also note a large improvement from "no filter" to "UV/IR Cut", as result of removing the unfocused light in the near infrared on my achromatic lens.

Based on my observations so far I have to agree with the theory that using an LP filter under dark skies improves the contrast of nebulae. Note that the impact of using the H-alpha filter is not as much as predicted in Table 1 because my H-alpha filter's pass band is quite a bit wider than the Orion brand one. My predictions show it to provide a +600% increase in RGB, so just a little better than the Astronomik UHC + UV/IR Cut, which is consistent with the observations.



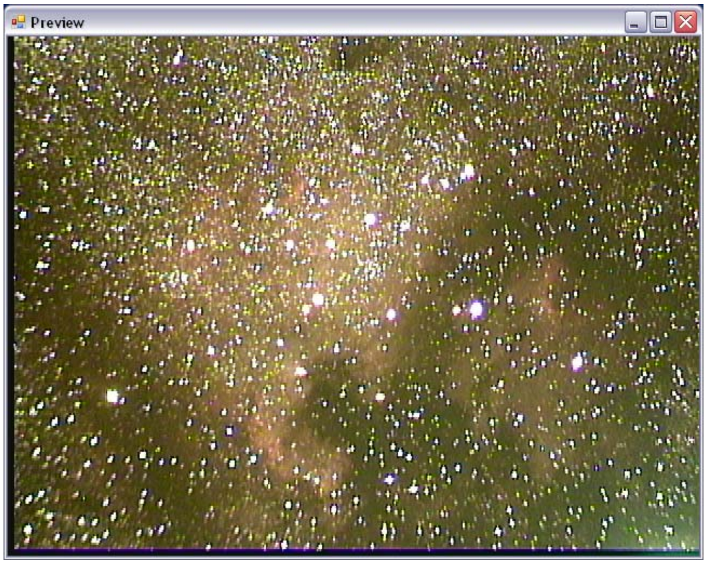
Baader Planetarium UV/IR Cut



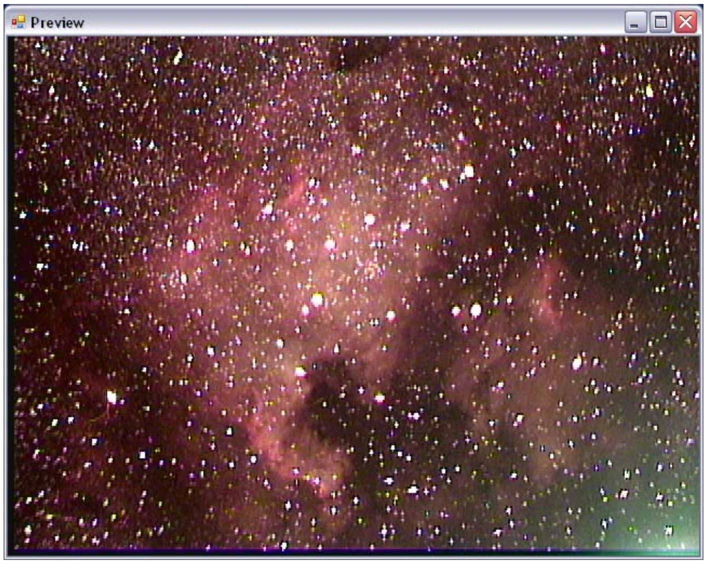
Astronomik UHC + BP UV/IR Cut

Omega Optical H-alpha

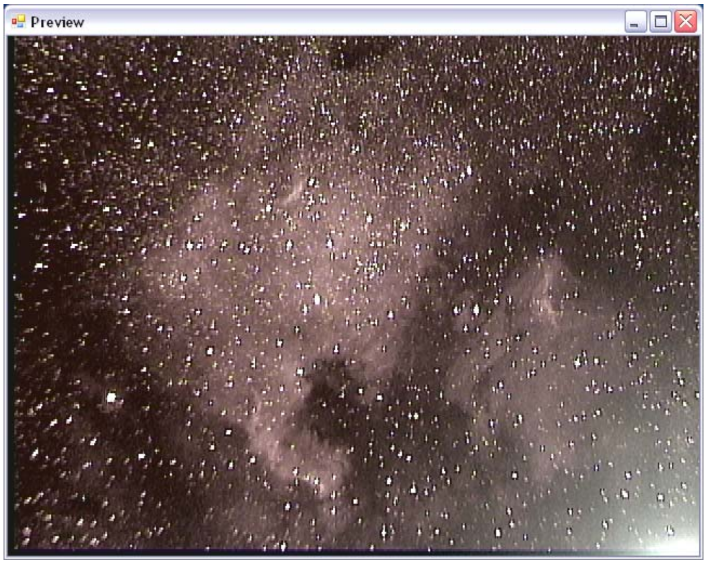
Figure 5 ***ngc7000 North American Nebula, same INT (120sec)***



Baader Planetarium UV/IR Cut (120sec)



Astronomik UHC + BP UV/IR Cut (180sec)



Omega Optical H-alpha (240sec)

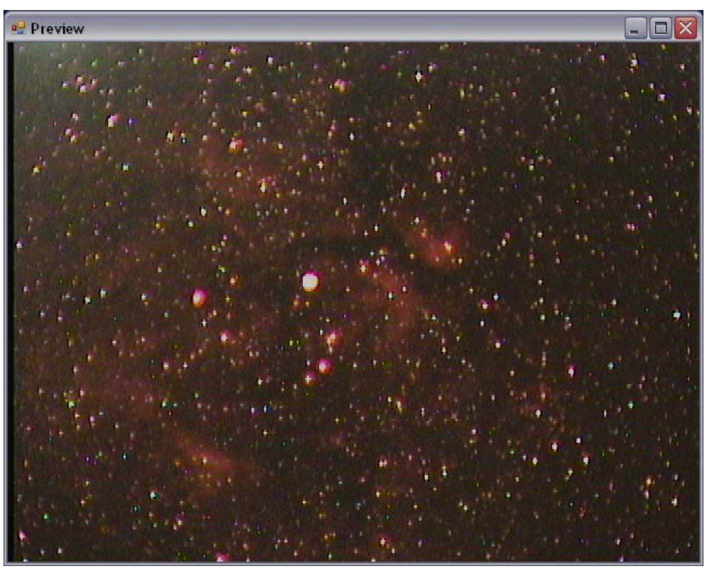
Figure 6 ngc7000 North American Nebula, same BRT (=0)

No Filters (25sec INT only, BRT=0)

Baader Planetarium UV/IR Cut

IDAS LPS-P2

Astronomik UHC + BP UV/IR Cut



Meade O-III + BDRB

Omega Optical H-Alpha

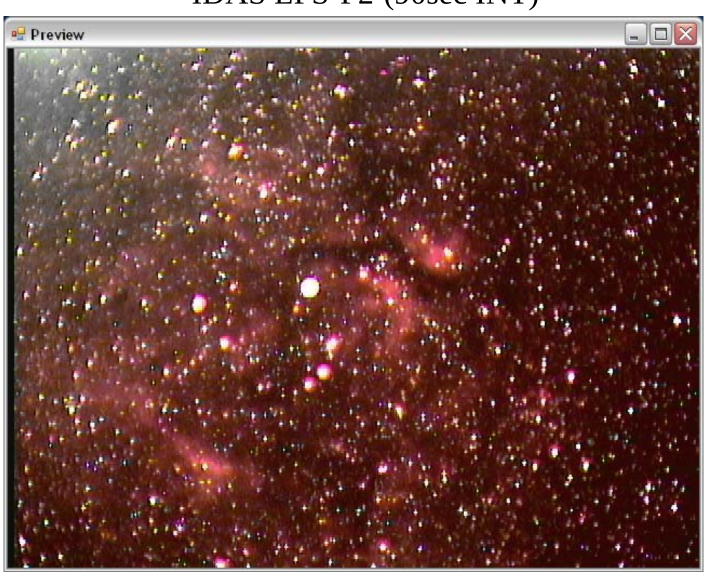
Figure 7 ***ic1318 Dragon Nebula, same INT (45sec)***

No Filters (20sec INT)

Baader Planetarium UV/IR Cut (45sec INT)

IDAS LPS-P2 (90sec INT)

Astronomik UHC + BP UV/IR Cut (180sec INT)



Meade O-III + BDRB (180sec INT)

Omega Optical H-Alpha (300sec INT)

Figure 8 ic1318 Dragon Nebula, same BRT (=0)

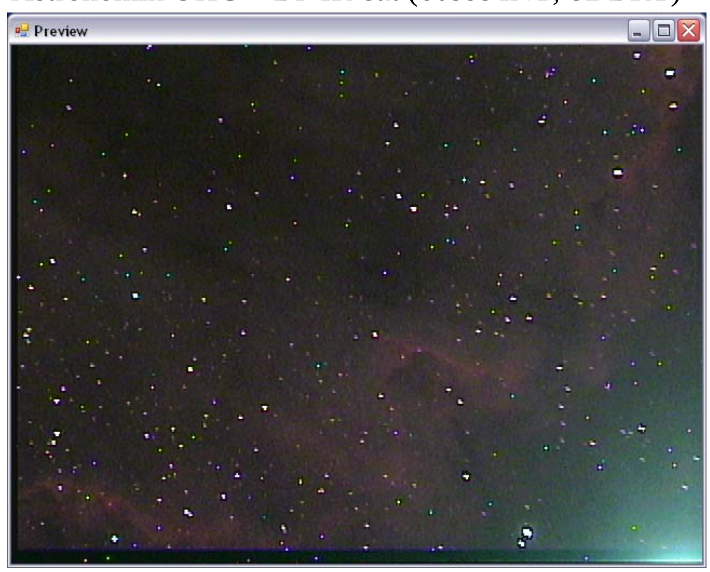
- July 21, 2012: Foymount

The following night I switched to a VRC8 for some closer in views. Since changing filters was more tedious with VRC, I only captured images for a couple of different filter combinations. The impact of the filters on stars was even more striking in these observations. There is a small reduction in the brightness of the nebula as you add progressively narrower filters, but the stars that clutter the field in the “no filter” configuration are greatly reduced. I find the result pleasing, and allows nebula details to be observed more clearly. As the filter band pass was narrowed, the amount of BRT adjustment increased, allowing me to go longer on my INT time to pull out even more detail.

No Filters (60sec INT, 54 BRT)

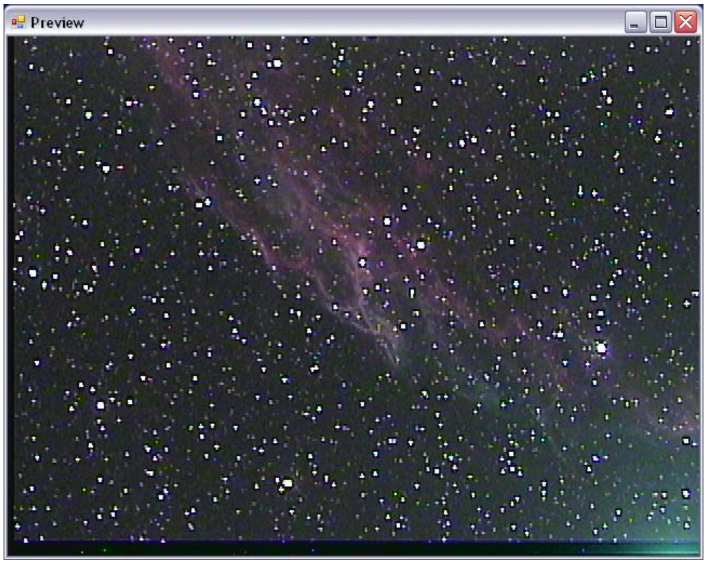
Astronomik UHC + BP IR cut (60sec INT, 82 BRT)

Meade O-III + BDRB (60sec INT, 93 BRT)

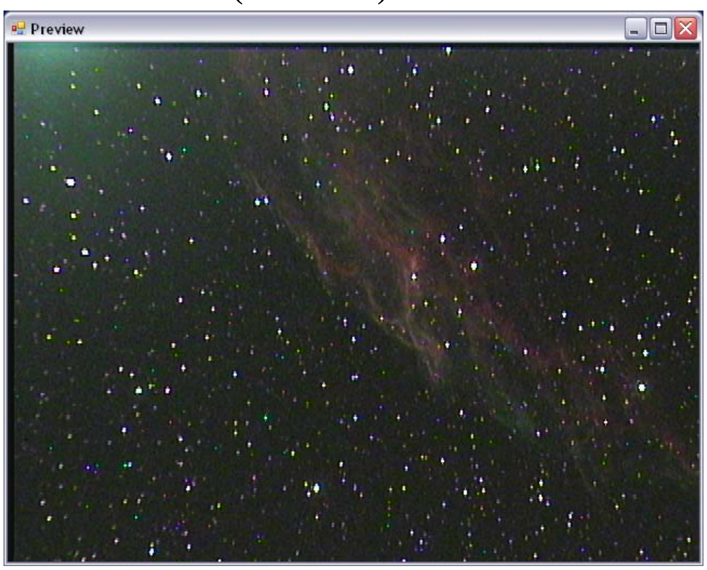


Meade O-III + BDRB (120sec INT, 82 BRT)

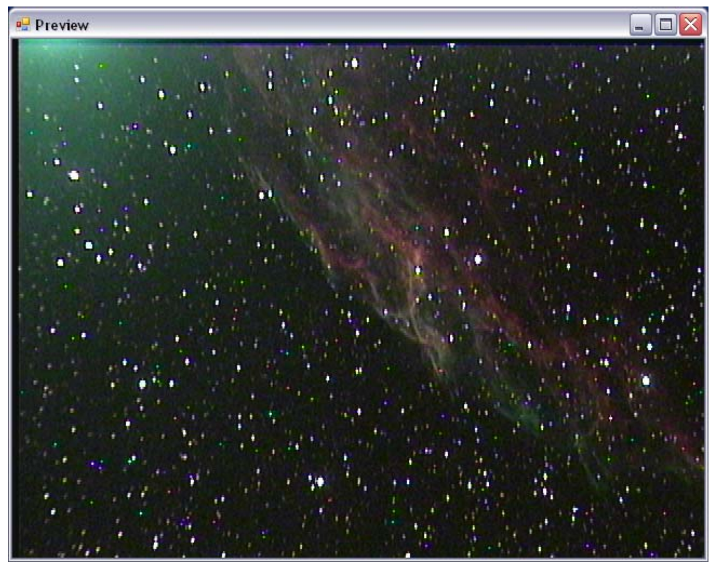
Figure 9   ngc7000 North American Nebula



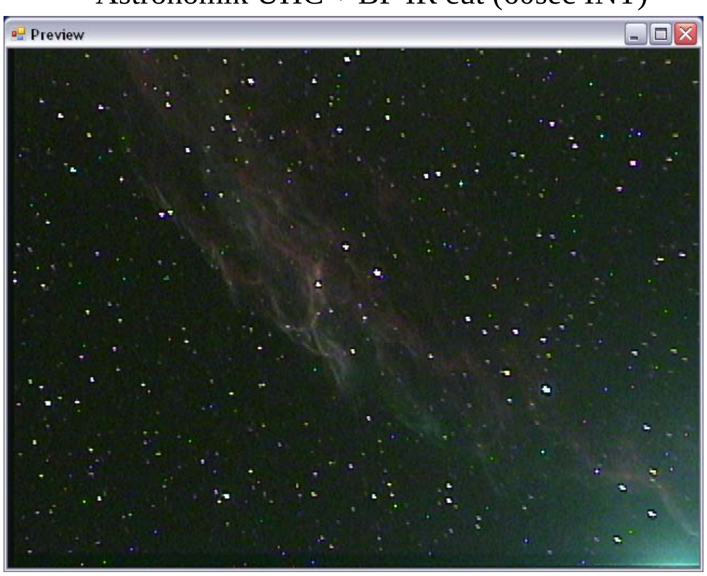
No Filters (60sec INT)



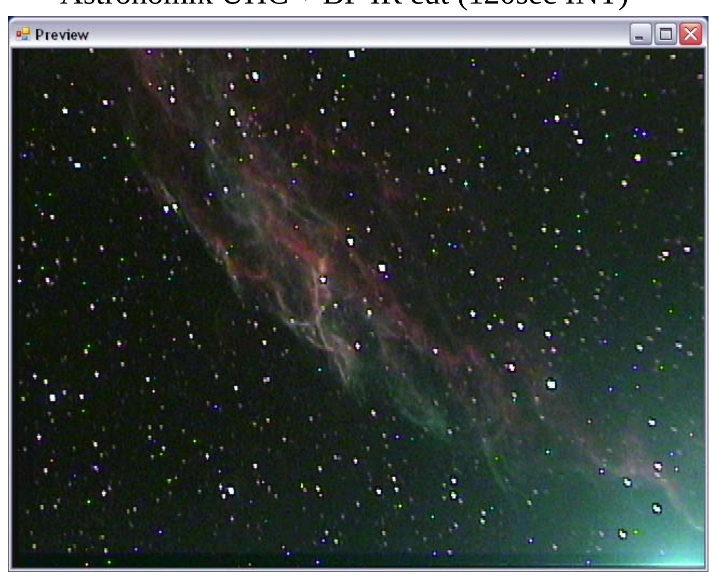
Astronomik UHC + BP IR cut (60sec INT)



Astronomik UHC + BP IR cut (120sec INT)



Meade O-III + BDRB (60sec INT)



Meade O-III + BDRB (120sec INT)

Figure 10 ngc6992 Veil Nebula

Conclusions:

Although my observations were not as systematic as I have done on other projects in the past, I feel that I have gathered enough evidence to say with a high level of confidence that using an LP filter under dark skies CAN improve the view of emission nebulae. I say “can” because for some people the effect of erasing stars from the scene so as to highlight the nebulosity may not be appealing to some people. To me it is. It also appears to be true that more contrast can be observed by using narrower LP filters. The further darkening of the background by using an LP filter is yet another improvement that I like, allowing me to go a little longer on my INT to bring out even more detail.

The benefit of using a UV/IR Cut filter on any DSO type (nebulae AND galaxies) while under dark skies is yet to be confirmed by observation. It looks like it may be confirmed on nebulae, but I need more observations to be sure. I will be sure to investigate further this coming summer season, and report back soon.

I hope my work is useful to the Mallincam community. If you have any questions, please feel free to contact me at: karmalimbo@yahoo.ca

Cheers,

Jim Thompson
AbbeyRoadObservatory